# Experimental and Research Station,

## Nursery & Market Garden Industries' -- Development Society, Limited. --

## Turner's Hill, Cheshunt, Herts.

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# Eleventh Annual Report, 1925.

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# *Experimental and Research Station.*

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# *Introduction.*

THE year 1925 has been an important one in the annals of the Station, for it saw the opening and occupation of new laboratories, the erection of which had become necessary to accommodate the augmented staff.

The original building consisted of two laboratories, each 20 ft. square, together with a small office and dark-room. The extension built on to the front of the original structure, is a double storied building having the office, director's laboratory and demonstration room on the ground floor ; two chemical laboratories, botanical laboratory and darkroom on the first floor, and an acid digestion room on the flat roof.

The new building was officially opened on June 17th by the Rt. Hon. Lord Bledisloe, P.C., K.B.E., Parliamentary Secretary to the Ministry of Agriculture. There was a representative gathering of nurserymen, scientists and friends of the Station, who, before luncheon, were shown through the glasshouses of Messrs. E. Stevens, Ltd., Cheshunt. It was estimated that the laboratories would be erected and equipped for the sum of £4,800, of which £2,800 was generously provided by the Ministry of Agriculture. The remaining sum has been partially defrayed by donations from growers and other interested friends, but the building fund is still £1,000 in debt. It is hoped that growers who have not yet subscribed will endeavour to do so as soon as possible.

The growers' problems are complex and difficult to solve, but results provided by the experiments conducted at various Experimental Stations, leave no doubt as to the practical value of such institutions.

It is a pleasure to note the continued interest in the Station investigations which is shown by all growers, owners, and workmen alike. During 1925 twenty-seven new members have been enrolled. This is encouraging,

but there is still room for improvement, and the governing body looks forward to the day when the Station will have the support of every grower of glasshouse crops in the country.

At the request of nursery foremen and other employees a new class of membership has been formed, namely, associate membership. This allows nursery employees, for a small subscription, to receive information from the Station. It is desirable, however, that when an employee avails himself of this opportunity his employer should be a member also.

A further development was made in the winter of 1924, when three scientific lectures were given by members of the staff to gatherings of nursery employees. These lectures were so successful that it was decided to arrange a more extensive series during the following winter.

The present series of cucumber experiments, started in 1922, have completely justified the attention bestowed upon them. A summary of the results collected during the past four years has been published in circular form in time for growers to make use of them when preparing for the 1926 crop. A full discussion is included in the present report.

The tomato experiments have been continued with satisfactory results. Previous findings concerning "blotchy ripening" have been confirmed, and a full discussion of this disorder is included. The experiments of 1924 emphasised the high manurial value of well-rotted turf and they have been extended during 1925 by testing the effect of digging into the soil dressings of turf, turf ash and grass. Excellent results have been obtained by heavy dressings of freshly cut grass. In one case the resulting yield approximated to that obtained in new soil.

These results are being fully developed in a new series of green manuring trials.

Fumigation of cucumber houses with naphthalene has been used extensively in nurseries, and a good control of

the red spider pest has been obtained. Owing to general conditions prevailing in tomato houses, where the pest has now become serious, naphthalene is not so effective.

Serious infestations of woodlice have been entirely eliminated by the use of a poison bait consisting of 28 lbs. bran and 1 lb. Paris green thoroughly mixed in a dry state, and broadcast on the soil surface.

A modification of the cyaniding process for tomato houses has been devised. A mixture of three parts sodium bicarbonate and one part sodium cyanide is distributed on the paths of the houses at the rate of one ounce to each one thousand cubic feet.

Investigations upon the effect of tetrachlorethane on chrysanthemums show that this fumigant cannot be used with safety on any variety.

The carbon dioxide investigations have been continued, and last year's results have been confirmed. Tomatoes submitted to a concentration of 0.06 per cent. carbon dioxide for one hour daily gave a crop increase of over twenty per cent. above the control. Indications were obtained that the increase in crop is most decided during the first two months of picking. This point is to be further examined. Cucumbers submitted to an average concentration of 0.09 per cent. carbon dioxide showed an increase in crop of twenty-five per cent. above control plants.

The chemical analysis of soils from various plots at the Station has been continued, and as a further aid to determining the correct manurial treatment for tomatoes, plants and fruits from some of the experimental plots are being analysed. Experiments with chemical compounds with a view to controlling the fungus, *Colletotrichum tabificum*, in glasshouse soils have been continued. None of the compounds so far examined is as effective as steam.

# DIRECTOR'S REPORT.

## Experimental Results of 1925.

The practice of grading the tomato fruits from the experimental plots adopted in 1921 was continued during the present season. The fruits are collected from each plot in numbered baskets and graded into seven grades as follows: —

A.—"Pinks" number 5 to 7 and "Pink and Whites" 8 to 10 to the lb. These are the best quality of fruit in size, shape and colour; "Pinks" being slightly larger than "Pink and Whites."

B.—"Whites." These are fruit of good colour but smaller than "Pink and Whites."

C.—"Blues." This grade consists of fruit of good colour but larger and more irregular in shape than Grade A.

D.—"Roughs." Small misshapen fruits about the size of cherries.

E.—Blotchy fruits which ripen irregularly.

F.—Fruits showing Blossom End Rot.

G.—Fruits showing the lesions of "Stripe Disease."

## Manurial Experiments with Tomatoes.

**(a) Series H. Top-dressing versus Base-dressing.**

The experiment in Series H was designed to test the relative values of the base and top-dressing fertiliser mixtures. The house was limed and divided into six plots. Two plots received base fertiliser only; two plots received top-dressing fertiliser only and two plots received both base and top-dressings. No stable manure was given during the three years of the experiment.

The results obtained during 1925 are given in Table I., while those collected during the last three years are shown in Table II.

In both 1923 and 1924 the decision was slightly in the favour of the plots receiving manures in the base only. These plots, however, occupied the best positions in the house, and one, plot 5, gave an abnormally high yield of 50 tons per acre

**Table I.**

**Series H. 1925.**

**Top-dressing v. Base-dressing.**

| Treatment. | Lbs. per Plant. | Tons per Acre. | % Blotchy Fruit. |
|---|---|---|---|
| Base-dressing only, H1 ... ... ... | 5.09 | 37.69 | — |
| ,, ,, ,, H4 ... ... ... | 5.31 | 40.61 | 0.94 |
| Top-dressing only, H2 ... ... ... | 5.45 | 41.43 | 0.19 |
| ,, ,, ,, H6 ... ... ... | 5.23 | 39.75 | 0.58 |
| Base and Top-dressing, H3 ... ... | 5.10 | 38.75 | 0.59 |
| ,, ,, ,, H5 ... ... | 6.16 | 46.83 | 0.16 |

**Table II.**

**Series H. 1923-1925.**

**Top-dressing v. Base-dressing.**

| Year. | TONS PER ACRE. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Base-dressing only. | | | Top-dressing only. | | | Base and Top-dressing. | | |
| | Plot 2. | Plot 5.* | Average | Plot 1. | Plot 4. | Average | Plot 3. | Plot 6. | Average |
| 1923 | 42.95 | 50.13 | 46.54 | 41.19 | 43.54 | 42.37 | 42.73 | 45.93 | 44.42 |
| 1924 | 46.59 | 44.67 | 45.63 | 40.50 | 42.17 | 41.34 | 41.59 | 43.66 | 43.63 |
| | Plot 1. | Plot 4. | Average. | Plot 2. | Plot 6. | Average | Plot 3. | Plot 5.* | Average |
| 1925 | 37.69 | 40.61 | 39.15 | 41.43 | 39.75 | 40.59 | 38.75 | 46.83 | 42.79 |

* Plot 5 gave abnormally high yields in 1923 and 1925.

in 1923. In 1925 the positions of the plots were changed in such a way, that base manurial treatments which had previously given the best yield were allocated to plots which had previously given a low one. The effect of this change showed results slightly in favour of the combined treatments, but here again they are affected by the high yield from plot 5.

After considering the results of this experiment during the past three years, the following conclusions seem reasonable: (1) That the quantities of manure applied per acre under the present manurial system are much in excess of the crop's requirements; because the base and top-dressing mixtures when used alone gave rise to similar crops, and the combination of both base and top-dressing treatments has not yet given a significantly higher yield than when each is used singly.

(2) Previous results have shown that manurial treatment must be regulated by the weather, because during a hot sunny season the tomato requires more nitrogen than when the season is dull and cold, and it requires more potash in a dull, cold season than in hot sunny weather.

It must be clearly understood by all growers that, strictly speaking, these results concerning base and top-dressing treatments apply only to nurseries where the conditions of cultivation approximate to those at the Station. At the same time the results are sufficiently important to warrant their repetition by every grower, because in these days of costly production it is necessary to apply only as much manure as is economically justifiable.

**Table III.**

**H1. Base-dressing only. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.71 | 1.78 | .34 | .14 | .14 | 4.11 | 30.24 | 80.75 |
| B. | — | .12 | .28 | .20 | .13 | .10 | .83 | 6.31 | 16.31 |
| C. | — | — | .04 | .01 | — | — | .05 | .38 | .98 |
| D. | — | — | .01 | .02 | .02 | — | .05 | .38 | .98 |
| E. | — | — | — | — | — | — | — | — | — |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | .02 | .03 | .05 | .38 | .98 |
| Total | — | 1.83 | 2.11 | .57 | .31 | .27 | 5.09 | 37.69 | 100 |

## Table IV.

**H2. Top-dressing only. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.78 | 1.57 | .28 | .12 | .27 | 4.02 | 30.55 | 73.76 |
| B. | — | .22 | .50 | .17 | .12 | .20 | 1.21 | 9.20 | 22.20 |
| C. | — | .01 | — | — | — | — | .01 | .08 | .19 |
| D. | — | — | .01 | .06 | .01 | .02 | .10 | .76 | 1.83 |
| E. | — | — | .01 | — | — | — | .01 | .08 | .19 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | .01 | .05 | .03 | .10 | .76 | 1.83 |
| Total | — | 2.00 | 2.11 | .52 | .30 | .52 | 5.45 | 41.43 | 100 |

## Table V.

**H3. Base and Top-dressing. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.46 | 1.61 | .34 | .08 | .13 | 3.62 | 27.51 | 70.99 |
| B. | — | .22 | .31 | .19 | .12 | .20 | 1.04 | 7.90 | 20.39 |
| C. | — | .01 | .07 | .02 | .02 | — | .12 | .91 | 2.35 |
| D. | — | .01 | .02 | .05 | .02 | .07 | .17 | 1.29 | 3.33 |
| E. | — | — | .01 | .01 | .01 | — | .03 | .23 | 0.59 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | .02 | .02 | .07 | .12 | .91 | 2.35 |
| Total | — | 1.70 | 2.03 | .63 | .27 | .47 | 5.10 | 38.75 | 100 |

## Table VI.

**H4. Base-dressing only. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.44 | 1.77 | .38 | .19 | .19 | 3.97 | 31.17 | 74.76 |
| B. | — | .19 | .31 | .16 | .14 | .18 | .98 | 7.45 | 18.46 |
| C. | — | — | .06 | .02 | .02 | — | .10 | .76 | 1.88 |
| D. | — | — | .04 | .06 | .01 | .04 | .15 | 1.14 | 2.83 |
| E. | — | .01 | .01 | .03 | — | — | .05 | .04 | .94 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | .02 | .02 | .06 | .05 | 1.13 |
| Total | — | 1.64 | 2.19 | .67 | .38 | .43 | 5.31 | 40.61 | 100 |

## Table VII.

**H5. Base and Top-dressing. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.01 | 1.90 | .32 | .20 | .27 | 4.70 | 35.72 | 76.30 |
| B. | — | .16 | .34 | .17 | .14 | .22 | 1.03 | 7.83 | 16.72 |
| C. | — | .01 | .08 | .02 | .01 | .09 | .21 | 1.60 | 3.41 |
| D. | — | — | .02 | .04 | .02 | — | .08 | .61 | 1.30 |
| E. | — | — | — | .01 | — | — | .01 | .08 | .16 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .02 | .03 | .03 | .05 | .13 | .99 | 2.11 |
| Total | — | 2.18 | 2.36 | .59 | .40 | .63 | 6.16 | 46.83 | 100 |

**Table VIII.**

**H6. Top-dressing only. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.61 | 1.87 | .38 | .16 | .15 | 4.17 | 31.69 | 79.73 |
| B. | — | .06 | .25 | .22 | .12 | .10 | .75 | 5.70 | 14.34 |
| C. | — | — | .07 | .01 | — | .01 | .09 | .68 | 1.72 |
| D. | — | — | .01 | .03 | .02 | .02 | .08 | .61 | 1.53 |
| E. | — | — | — | .03 | — | — | .03 | .23 | .58 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | .04 | .02 | .04 | .11 | .84 | 2.10 |
| Total | — | 1.67 | 2.21 | .71 | .32 | .32 | 5.23 | 39.75 | 100 |

## Manurial Treatment of Series H.

**Base Manure.**

1 lb. Lime per sq. yd.
No Stable Manure.
¾ lb. per sq. yd. of the following mixture:—
1 part Bone Meal.
1 part Bone Flour.
1 part Hoof and Horn.
1 part Sulphate of Potash.

**Top-dressing.**

Mulch of Stable Manure.
Eight dressings, each consisting of 2 ozs. per sq. yd. of the following mixture:—
3 parts Sulphate of Ammonia.
2 parts Dried Blood.
7 parts 30% Superphosphate.
5 parts Pure Dissolved Bones.
½ part Bone Flour.
2½ parts Sulphate of Potash.

**Table IX. Series J, 1925.**

| TREATMENT. | | Lbs. pr. Plant. | Tonspr. Acre. | % Blotchy Fruits. |
|---|---|---|---|---|
| J1. | Twice complete artificials ... ... ... | 4.85 | 36.86 | 0.62 |
| J2a. | Unmanured ... ... ... ... ... ... | 3.35 | 26.56 | 33.23 |
| J2b. | Stable manure only ... ... ... ... | 4.71 | 35.80 | 1.90 |
| J3. | Base phosphates as basic slag ... ... ... | 5.28 | 40.28 | 1.14 |
| J4. | Base phosphates as bone meal and bone flour | 5.41 | 41.12 | 0.75 |
| J5. | Complete artificials ... ... ... ... | 5.34 | 40.57 | 0.94 |
| J6a. | No phosphates ... ... ... ... ... | 5.77 | 43.87 | 0.71 |
| J6b. | 16 per cent. phosphates ... ... ... ... | 5.47 | 41.27 | 0.36 |
| J6c. | 24 per cent. phosphates ... ... ... ... | 5.43 | 41.19 | 0.19 |
| J6d. | 32 per cent. phosphates ... ... ... ... | 5.50 | 41.81 | 0.19 |
| J7a. | No nitrogen ... ... ... ... ... ... | 3.92 | 30.00 | 6.60 |
| J7b. | 2½ per cent. nitrogen ... ... ... ... | 4.57 | 34.73 | — |
| J7c. | 5 per cent. nitrogen ... ... ... ... | 5.21 | 39.45 | 0.96 |
| J7d. | 7½ per cent. nitrogen ... ... ... ... | 5.78 | 43.93 | 0.70 |
| J8a. | No potash ... ... ... ... ... ... | 3.75 | 28.51 | 25.04 |
| J8b. | 5 per cent. potash ... ... ... ... ... | 5.39 | 40.97 | 4.08 |
| J8c. | 7½ per cent. potash... ... ... ... ... | 5.42 | 41.21 | 2.96 |
| J8d. | 10 per cent. potash... ... ... ... ... | 5.50 | 41.80 | 0.91 |

**Table X.**

The effect of increasing quantities of phosphates, nitrogen and potash during 1923–1925.

| Fertiliser. | | 1923. | | *1924. | | 1925. | |
|---|---|---|---|---|---|---|---|
| | | Tons per Acre. | % Blotchy Fruit. | Tons per Acre. | % Blotchy Fruit. | Tons per Acre. | % Blotchy Fruit. |
| Phosphates | 0 ... | 38.08 | 1.60 | 44.60 | 2.22 | 43.87 | 0.71 |
| ,, | 8% ... | 33.67 | 0.68 | 44.53 | 1.37 | — | — |
| ,, | 16% ... | 34.89 | 2.61 | 44.60 | 0.18 | 41.27 | 0.36 |
| ,, | 24% ... | 33.14 | 2.98 | 47.92 | 0.44 | 41.19 | 0.19 |
| ,, | 32% ... | — | — | — | — | 41.81 | 0.19 |
| Nitrogen | 0 ... | 35.64 | 10.23 | 40.56 | 3.75 | 30.00 | 6.60 |
| ,, | 1¼% ... | 43.40 | 4.73 | 48.72 | 0.78 | — | — |
| ,, | 2½% ... | 38.15 | 3.98 | 51.00 | 0.16 | 34.73 | — |
| ,, | 5% ... | 41.80 | 2.00 | 53.88 | 0.27 | 39.45 | 0.96 |
| ,, | 7½% ... | — | — | — | — | 43.93 | 0.70 |
| Potash | 0 ... | 34.28 | 22.39 | 45.00 | 18.07 | 28.51 | 25.04 |
| ,, | 2½% ... | 35.87 | 12.50 | 45.19 | 6.22 | — | — |
| ,, | 5% ... | 36.86 | 12.16 | 46.73 | 4.39 | 40.97 | 4.08 |
| ,, | 7½% ... | 44.68 | 14.80 | 50.99 | 3.57 | 41.21 | 2.96 |
| ,, | 10% ... | — | — | — | — | 41.80 | 0.96 |

* The soil of the plots was steam sterilised between the seasons of 1923 and 1924.

**(b) Series J and K.**

The ultimate object of these experiments is to determine the correct proportions of phosphatic, nitrogenous and potassic fertilisers in a satisfactory tomato mixture. The results from Series J during the past season are summarised in Table IX. and set out in detail in Tables XI. to XXVIII.

Once more the crop from Plot J1, which receives a double dressing of Complete Artificials is less than that from Plot J5 where a single dressing only is given.

Plot 2, which has been unmanured except for an annual dressing of lime since 1919, was divided into two plots, one of which, J2a, remained unmanured while the other, J2b, received 14 lbs. stable manure to each square yard. The unmanured plot yielded at the rate of 26.56 tons per acre, while the manured plot gave 35.8 tons per acre, representing an increase of 34.5 per cent. as the result of applying 14 lbs. stable manure per square yard to soil unmanured for seven years. J3 and J4, in which the base phosphates were given in the form of basic slag, and bone meal and bone flour respectively, showed as in the previous two years that there is little to choose between these two forms of phosphate.

Plots J6a to J6d, J7a to J7d, and J8a to J8d have given interesting results. The yields of the past three years are set out in Table X. It will be seen that during that period no benefit has been derived from applying phosphates, for the weight and quality of the fruit from each small plot is practically the same.

Plots J7a to J7d, to which different quantities of sulphate of ammonia have been applied, indicate that higher yields are obtained as the amount of this fertiliser is increased, also in the same way the percentage of "blotchy ripening" is reduced. It is necessary to continue this experiment still further as there are no indications that the optimum quantity of nitrogen has yet been reached.

In the potash series, J8a to J8d, the crop has increased and "blotchy ripening" has decreased with increasing dressings of sulphate of potash. There are indications, however, that the optimum dressing has been reached, for ten per cent. of potash as $K_2O$ in the fertiliser mixture has reduced the percentage of "blotchy ripening" to a nominal figure of 0.96.

Series K remained as in previous years, and will continue so until other experiments yield results which require confirmation in soil treated as in this series. The results are summarised in Table XXIX. and shown in more detail in Tables XXX. to XXXVII.

## Table XI.

**J1. Double Complete Artificials (Formula II.).**

**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .72 | 1.44 | .26 | .08 | .19 | 2.69 | 20.44 | 55.46 |
| B. | — | .44 | .70 | .31 | .18 | .25 | 1.88 | 14.29 | 38.77 |
| C. | — | — | .04 | .01 | .04 | — | .09 | .68 | 1.85 |
| D. | — | — | .02 | .06 | .02 | .05 | .15 | 1.14 | 3.09 |
| E. | — | .01 | — | .02 | — | — | .03 | .23 | .62 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .01 | — | — | .01 | .08 | .21 |
| Total | — | 1.17 | 2.20 | .67 | .32 | .49 | 4.85 | 36.86 | 100 |

## Table XII.

**J2a. Unmanured.** **Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .34 | .65 | .13 | .09 | .12 | 1.33 | 10.11 | 38.79 |
| B. | — | .13 | .35 | .10 | .08 | .14 | .80 | 6.68 | 25.64 |
| C. | — | — | .01 | .01 | — | — | .02 | .15 | .58 |
| D. | — | — | — | .02 | .02 | .01 | .05 | .38 | 1.46 |
| E. | — | .75 | .26 | .11 | .02 | — | 1.14 | 8.66 | 33.23 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .01 | — | — | .01 | .08 | .30 |
| Total | — | 1.22 | 1.27 | .38 | .21 | .27 | 3.35 | 26.06 | 100 |

## Table XIII.

**J2b. Stable Manure only. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.03 | 1.55 | .21 | .11 | .31 | 3.21 | 24.40 | 68.16 |
| B. | — | .26 | .48 | .10 | .15 | .24 | 1.23 | 9.35 | 26.11 |
| C. | — | — | .05 | .01 | — | .01 | .07 | .53 | 1.48 |
| D. | — | — | .01 | .05 | .02 | .03 | .11 | .84 | 2.35 |
| E. | — | .04 | .01 | .03 | .01 | — | .09 | .68 | 1.90 |
| F. | — | — | — | — | — | — | — | - | — |
| G. | — | — | — | — | — | — | — | — | — |
| Total | — | 1.33 | 2.10 | .40 | .29 | .59 | 4.71 | 35.80 | 100 |

## Table XIV.

**J3. Phosphates as Basic Slag. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.00 | 1.71 | .48 | .13 | .10 | 3.42 | 25.99 | 64.52 |
| B. | — | .36 | .65 | .33 | .15 | .08 | 1.57 | 11.93 | 29.61 |
| C. | — | .03 | .03 | .02 | — | — | .08 | .61 | 1.52 |
| D. | — | — | .02 | .09 | .03 | .01 | .15 | 1.14 | 2.84 |
| E. | — | — | .01 | .03 | — | — | .04 | .46 | 1.14 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | — | — | .02 | .15 | .37 |
| Total | — | 1.39 | 2.42 | .97 | .31 | .19 | 5.28 | 40.28 | 100 |

## Table XV.

**J4. Base Phosphates as Bone Meal and Bone Flour.**

**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.04 | 1.88 | .40 | .12 | .23 | 3.67 | 27.89 | 67.82 |
| B. | — | .27 | .55 | .33 | .12 | .24 | 1.51 | 11.48 | 27.92 |
| C. | — | .01 | .02 | .02 | — | — | .05 | .38 | .92 |
| D. | — | — | .01 | .07 | .01 | .03 | .12 | .91 | 2.22 |
| E. | — | — | .03 | .01 | — | — | .04 | .31 | .75 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | .01 | — | — | .02 | .15 | .37 |
| Total | — | 1.32 | 2.50 | .84 | .25 | .50 | 5.41 | 41.12 | 100 |

## Table XVI.

**J5. Complete Artificials (Formula II.).**

**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | | 1.20 | 1.76 | .35 | .20 | .33 | 3.84 | 29.18 | 71.92 |
| B. | — | .18 | .26 | .14 | .22 | .32 | 1.12 | 8.51 | 20.97 |
| C. | — | .06 | .05 | .02 | .01 | — | .14 | 1.06 | 2.62 |
| D. | — | — | .01 | .03 | .04 | .04 | .12 | .91 | 2.24 |
| E. | — | — | .01 | .01 | — | .03 | .05 | .38 | .94 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | .02 | .03 | .07 | .53 | 1.31 |
| Total | — | 1.44 | 2.09 | .57 | .49 | .75 | 5.34 | 40.57 | 100 |

## Table XVII.

**J6a. Complete Artificials (II.) without Phosphates.**

**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.38 | 1.71 | .51 | .27 | .23 | 4.10 | 31.16 | 71.03 |
| B. | — | .17 | .51 | .30 | .20 | .35 | 1.53 | 11.63 | 26.51 |
| C. | — | — | .01 | — | — | — | .01 | .08 | .18 |
| D. | — | — | — | .06 | — | — | .06 | .46 | 1.05 |
| E. | — | — | — | .01 | .01 | .02 | .04 | .31 | .71 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | .01 | — | .03 | .23 | .52 |
| Total | — | 1.55 | 2.23 | .90 | .49 | .60 | 5.77 | 43.87 | 100 |

## Table XVIII.

**J6b. 16% Phosphates.** **Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.17 | 1.84 | .40 | .17 | .24 | 3.82 | 29.03 | 70.34 |
| B. | — | .25 | .52 | .26 | .09 | .30 | 1.42 | 10.79 | 26.15 |
| C. | — | .01 | .05 | .04 | — | — | .10 | .76 | 1.84 |
| D. | — | — | — | .02 | — | .02 | .04 | .23 | .56 |
| E. | — | — | .01 | .01 | .01 | — | .03 | .15 | .36 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | .03 | .01 | .06 | .31 | .75 |
| Total | — | 1.43 | 2.42 | .75 | .30 | .57 | 5.47 | 41.27 | 100 |

## Table XIX.

**J6c. 24% Phosphates. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.21 | 1.82 | .30 | .19 | .27 | 3.79 | 28.80 | 69.93 |
| B. | — | .25 | .58 | .24 | .14 | .28 | 1.49 | 11.32 | 27.49 |
| C. | — | — | .03 | — | — | — | .03 | .23 | .55 |
| D. | — | — | — | .05 | — | .03 | .08 | .53 | 1.29 |
| E. | — | — | — | — | .01 | — | .01 | .08 | .19 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .01 | .02 | — | .03 | .23 | .55 |
| Total | — | 1.46 | 2.43 | .60 | .36 | .58 | 5.43 | 41.19 | 100 |

## Table XX.

**J6d. 32% Phosphates. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.34 | 1.99 | .21 | .21 | .26 | 4.01 | 30.48 | 72.91 |
| B. | — | .18 | .61 | .13 | .18 | .23 | 1.33 | 10.11 | 24.17 |
| C. | — | .01 | .05 | .01 | — | — | .07 | .53 | 1.27 |
| D. | — | — | — | .02 | .01 | — | .03 | .23 | .55 |
| E. | — | — | — | — | — | .01 | .01 | .08 | .19 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | .03 | — | .05 | .38 | .91 |
| Total | — | 1.53 | 2.65 | .39 | .43 | .50 | 5.50 | 41.81 | 100 |

## Table XXI.

**J7a. Complete Artificials (II.) without Nitrogen.**
**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.07 | .64 | .15 | .22 | .25 | 2.33 | 17.91 | 59.70 |
| B. | — | .11 | .22 | .11 | .30 | .30 | 1.04 | 7.90 | 26.34 |
| C. | — | .02 | .02 | — | — | — | .04 | .31 | 1.03 |
| D. | — | — | — | .01 | .07 | — | .08 | .61 | 2.03 |
| E. | — | .07 | .15 | — | .01 | .03 | .26 | 1.98 | 6.60 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | .16 | .01 | .17 | 1.29 | 4.30 |
| Total | — | 1.27 | 1.03 | .27 | .76 | .59 | 3.92 | 30.00 | 100 |

## Table XXII.

**J7b. 2½% Nitrogen.** **Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.33 | 1.50 | .12 | .18 | .30 | 3.43 | 26.07 | 75.06 |
| B. | — | .17 | .41 | .08 | .14 | .26 | 1.06 | 8.05 | 23.19 |
| C. | — | — | — | — | — | — | — | — | — |
| D. | — | — | — | .02 | .01 | — | .03 | .23 | .66 |
| E. | — | — | — | — | — | — | — | — | — |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | — | .04 | — | .05 | .38 | 1.09 |
| Total | — | 1.50 | 1.92 | .22 | .37 | .56 | 4.57 | 34.73 | 100 |

## Table XXIII.

**J7c. 5% Nitrogen. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.34 | 1.45 | .19 | .19 | .39 | 3.56 | 27.06 | 68.60 |
| B. | — | .22 | .61 | .06 | .20 | .33 | 1.42 | 10.79 | 27.36 |
| C. | — | — | — | — | — | — | — | — | — |
| D. | — | — | — | .02 | — | .03 | .05 | .31 | .78 |
| E. | — | .03 | .03 | — | — | — | .06 | .38 | .96 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | .06 | .04 | .12 | .91 | 2.30 |
| Total | — | 1.59 | 2.09 | .29 | .45 | .79 | 5.21 | 39.45 | 100 |

## Table XXIV.

**J7d. 7½% Nitrogen. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.56 | 1.96 | .23 | .21 | .43 | 4.39 | 33.36 | 25.93 |
| B. | — | .09 | .42 | .09 | .21 | .32 | 1.13 | 8.59 | 19.55 |
| C. | — | — | .05 | — | .02 | — | .07 | .53 | 1.21 |
| D. | — | — | — | .02 | — | — | .02 | .15 | .35 |
| E. | — | .01 | .02 | — | .01 | — | .04 | .31 | .70 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .03 | .07 | .04 | .14 | .99 | 2.26 |
| Total | — | 1.66 | 2.45 | .37 | .52 | .79 | 5.79 | 43.93 | 100 |

## Table XXV.

**J8a. Complete Artificials (II.) without Potash.**

**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .67 | .83 | .13 | .18 | .28 | 2.09 | 15.88 | 55.70 |
| B. | — | .04 | .20 | .08 | .08 | .26 | .66 | 5.02 | 17.61 |
| C. | — | — | .01 | — | — | — | .01 | .08 | .28 |
| D. | — | — | — | — | — | .01 | .01 | .08 | .28 |
| E. | — | .46 | .39 | .03 | .02 | .04 | .94 | 7.14 | 25.04 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | .04 | — | .04 | .31 | 1.09 |
| Total | — | 1.17 | 1.43 | .24 | .32 | .59 | 3.75 | 28.51 | 100 |

## Table XXVI.

**J8b. 5% Potash.** **Variety - "Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.14 | 1.63 | .21 | .42 | .36 | 3.76 | 28.58 | 69.74 |
| B. | — | .19 | .37 | .12 | .22 | .32 | 1.22 | 9.27 | 22.62 |
| C. | — | .01 | — | — | .02 | — | .03 | .23 | .57 |
| D. | — | — | — | .03 | — | — | .03 | .23 | .57 |
| E. | — | .12 | .06 | .02 | .02 | — | .22 | 1.67 | 4.08 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .03 | .06 | .04 | .13 | .99 | 2.42 |
| Total | — | 1.46 | 2.06 | .41 | .74 | .72 | 5.39 | 40.97 | 100 |

## Table XXVII.

**J8c. 7½% Potash. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.21 | 1.69 | .25 | .18 | .34 | 3.67 | 27.89 | 67.67 |
| B. | — | .18 | .54 | .09 | .20 | .34 | 1.35 | 10.26 | 24.91 |
| C. | — | .03 | — | .01 | — | — | .04 | .31 | .75 |
| D. | — | — | — | .01 | .01 | .02 | .04 | .31 | .75 |
| E. | — | .05 | .04 | .01 | .03 | .03 | .16 | 1.22 | 2.96 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | .09 | .05 | .16 | 1.22 | 2.96 |
| Total | — | 1.47 | 2.27 | .39 | .51 | .78 | 5.42 | 41.21 | 100 |

## Table XXVIII.

**J8d. 10% Potash. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.30 | 1.98 | .21 | .16 | .39 | 4.04 | 30.70 | 73.43 |
| B. | — | .21 | .32 | .14 | .10 | .37 | 1.14 | 8.66 | 20.71 |
| C. | — | .02 | .03 | — | — | — | .05 | .38 | .91 |
| D. | — | — | — | .01 | .02 | .03 | .06 | .46 | 1.11 |
| E. | — | .01 | .02 | .01 | .01 | — | .05 | .38 | .91 |
| F. | — | .01 | — | — | — | — | .01 | .08 | .20 |
| G. | — | — | — | .04 | .08 | .03 | .15 | 1.14 | 2.73 |
| Total | — | 1.55 | 2.35 | .41 | .37 | .82 | 5.50 | 41.80 | 100 |

## Table XXIX.

### Series K, 1925.

| TREATMENT. | Lbs. per Plant. | Tons per Acre. | % Blotchy Fruit. |
|---|---|---|---|
| K1. Twice Complete Artificials ... ... | 4.39 | 33.37 | 1.40 |
| K2. Unmanured ... ... ... ... ... | 2.52 | 19.14 | 43.25 |
| K3. Complete Artificials with Standard ... | 4.10 | 31.16 | 1.93 |
| K4. Complete Artificials with Dung ... | 4.90 | 37.24 | 0.41 |
| K5. Complete Artificials ... ... ... | 4.63 | 35.34 | — |
| K6. Complete Artificials less Phosphates ... | 4.44 | 33.74 | 1.35 |
| K7. Complete Artificials less Nitrogen ... | 3.25 | 24.69 | 8.92 |
| K8. Complete Artificials less Potash ... | 3.74 | 28.43 | 24.87 |

## Table XXX.

### K1. Twice Complete Artificials (Formula I.).

**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .77 | .59 | .24 | .15 | .13 | 1.88 | 14.29 | 42.82 |
| B. | — | .77 | .53 | .32 | .23 | .22 | 2.07 | 15.73 | 47.14 |
| C. | — | .10 | .06 | .01 | .01 | — | .18 | 1.36 | 4.08 |
| D. | — | — | .03 | .07 | .03 | .03 | .16 | 1.22 | 3.65 |
| E. | — | — | .02 | .03 | — | .01 | .06 | .46 | 1.40 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | .02 | .01 | — | .04 | .31 | .91 |
| Total | — | 1.64 | 1.24 | .69 | .43 | .39 | 4.39 | 33.37 | 100 |

## Table XXXI.

**K2. Unmanured. Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .27 | .23 | .10 | .06 | .08 | .74 | 5.62 | 29.36 |
| B. | — | .04 | .11 | .06 | .05 | .09 | .35 | 2.66 | 13.89 |
| C. | — | .16 | .10 | .02 | .01 | — | .29 | 2.20 | 11.51 |
| D. | — | — | .02 | .01 | — | .02 | .05 | .38 | 1.99 |
| E. | — | .85 | .12 | .11 | .01 | — | 1.09 | 8.28 | 43.25 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | — | — | — | — | — |
| Total | — | 1.32 | .58 | .30 | .13 | .19 | 2.52 | 19.14 | 100 |

## Table XXXII.

**K3. Complete Artificials (I.) with Standard.**
**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .60 | .89 | .28 | .17 | .09 | 2.03 | 15.43 | 49.51 |
| B. | — | .68 | .62 | .31 | .12 | .11 | 1.84 | 13.98 | 44.87 |
| C. | — | — | .02 | .01 | — | — | .03 | .23 | .73 |
| D. | — | — | .03 | .06 | .01 | — | .10 | .76 | 2.44 |
| E. | — | .01 | — | .02 | .04 | .01 | .08 | .60 | 1.93 |
| F. | — | .01 | — | — | — | — | .01 | .08 | .26 |
| G. | — | — | — | .01 | — | — | .01 | .08 | .26 |
| Total | — | 1.30 | 1.56 | .69 | .34 | .21 | 4.10 | 31.16 | 100 |

## Table XXXIII.

**K4. Complete Artificials (I.) with Stable Manure.**
**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .92 | 1.23 | .41 | .18 | .16 | 2.90 | 22.04 | 59.18 |
| B. | — | .57 | .55 | .33 | .17 | .15 | 1.77 | 13.45 | 36.12 |
| C. | — | .04 | .03 | .01 | — | — | .08 | .61 | 1.63 |
| D. | — | — | .01 | .04 | .05 | .02 | .12 | .91 | 2.45 |
| E. | — | — | — | .02 | — | — | .02 | .15 | .41 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | — | — | — | .01 | .08 | .21 |
| Total | — | 1.53 | 1.83 | .81 | .40 | .33 | 4.90 | 37.24 | 100 |

## Table XXXIV.

**K5. Complete Artificials (I.).** **Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.01 | 1.16 | .31 | .24 | .23 | 2.95 | 22.57 | 63.72 |
| B. | — | .52 | .37 | .21 | .23 | .14 | 1.47 | 11.17 | 31.75 |
| C. | — | .01 | .05 | .02 | — | — | .08 | .61 | 1.73 |
| D. | — | — | .02 | .02 | .03 | .04 | .11 | .84 | 2.37 |
| E. | — | — | — | — | — | — | — | — | — |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | .01 | — | — | .02 | .15 | .43 |
| Total | — | 1.54 | 1.61 | .57 | .50 | .41 | 4.63 | 35.34 | 100 |

## Table XXXV.

**K6. Complete Artificials (I.) without Phosphates.**
**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .95 | .96 | .32 | .25 | .16 | 2.64 | 20.06 | 59.46 |
| B. | — | .41 | .42 | .22 | .21 | .23 | 1.49 | 11.32 | 33.56 |
| C. | — | .01 | .04 | .01 | .02 | — | .08 | .61 | 1.80 |
| D. | — | — | .03 | .03 | .01 | .02 | .09 | .68 | 2.03 |
| E. | — | — | .03 | .03 | — | — | .06 | .46 | 1.35 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .04 | .03 | — | — | .08 | .61 | 1.80 |
| Total | — | 1.38 | 1.52 | .64 | .49 | .41 | 4.44 | 33.74 | 100 |

## Table XXXVI.

**K7. Complete Artificials (I.) without Nitrogen.**
**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .98 | .53 | .23 | .11 | .14 | 1.99 | 15.12 | 61.23 |
| B. | — | .33 | .13 | .23 | .11 | .04 | .84 | 6.38 | 25.85 |
| C. | — | .02 | .01 | .02 | — | — | .05 | .38 | 1.54 |
| D. | — | — | .01 | .01 | .02 | .02 | .06 | .46 | 1.85 |
| E. | — | .11 | .08 | .08 | .02 | — | .29 | 2.20 | 8.92 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .02 | — | — | .02 | .15 | 0.61 |
| Total | — | 1.44 | .76 | .59 | .26 | .20 | 3.25 | 24.69 | 100 |

## Table XXXVII.

**K8. Complete Artificials without Potash.**

**Variety—"Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .55 | .50 | .12 | .11 | .15 | 1.43 | 10.87 | 38.23 |
| B. | — | .40 | .35 | .10 | .16 | .21 | 1.22 | 9.27 | 32.62 |
| C. | — | .01 | .03 | .02 | — | — | .06 | .46 | 1.60 |
| D. | — | — | — | .02 | .01 | .04 | .07 | .53 | 1.88 |
| E. | — | .42 | .34 | .16 | .01 | — | .93 | 7.07 | 24.87 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .02 | .01 | — | — | .03 | .23 | .80 |
| Total | — | 1.38 | 1.24 | .43 | .29 | .40 | 3.74 | 28.43 | 100 |

## Table XXXVIII.

### Manures applied in Series J. and K.

| Plot. | TITLE. | Base Manure in Lbs. per sq. yd. | | | | | | | | *Top-dressing in Lbs. per sq. yd. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lime. | Stable Manure. | Basic Slag. | Bone Meal. | Bone Flour. | Ground Hoofs. | Sulphate of Potash. | Sulphate of Ammonia. | Super. Phosphate. | Sulphate of Ammonia. | Nitrate of Soda. | Sulphate of Potash. |
| J1 | Double Complete Artificials (Formula II.) | 1.0 | — | 0.8 | — | — | — | 0.2 | — | 2.6 | 0.8 | — | 0.6 |
| J2a | Unmanured | 1.0 | — | — | — | — | — | — | — | — | — | — | — |
| J2b | Stable Manure only | 1.0 | 14 | — | — | — | — | — | — | — | — | — | — |
| J3 | Phoshates as Bone Meal and Bone Flour | 1.0 | 14 | — | 0.25 | 0.25 | — | 0.25 | — | 1.3 | 0.4 | — | 0.3 |
| J4 | Phosphates as Basic Slag | 1.0 | 14 | 1.46 | — | — | — | 0.25 | 0.057 | 1.3 | 0.4 | — | 0.3 |
| J5 | Complete Artificials (II.) | 1.0 | — | 0.4 | — | — | — | 0.1 | — | 1.3 | 0.4 | — | 0.3 |
| J6a | Complete Artificials (II.) without Phosphates | 1.0 | — | — | — | — | — | 0.1 | — | — | 0.4 | — | 0.3 |
| 6b | Complete Artificials (II.) with 8% Phosphates | 1.0 | — | — | — | — | — | 0.1 | — | 0.8 | 0.4 | — | 0.3 |
| 6c | Complete Artificials (II.) with 16% Phosphates | 1.0 | — | — | — | — | — | 0.1 | — | 1.3 | 0.4 | — | 0.3 |
| 6d | Complete Artificials (II.) with 24% Phosphates | 1.0 | — | — | — | — | — | 0.1 | — | 1.7 | 0.4 | — | 0.3 |
| J7a | Complete Artificials (II.) without Nitrogen | 1.0 | — | 0.4 | — | — | — | 0.1 | — | 1.3 | — | — | 0.3 |
| 7b | Complete Artificials (II.) with 1¼% Nitrogen | 1.0 | — | 0.4 | — | — | — | 0.1 | — | 1.3 | 0.2 | — | 0.3 |
| 7c | Complete Artificials (II.) with 2½% Nitrogen | 1.0 | — | 0.4 | — | — | — | 0.1 | — | 1.3 | 0.4 | — | 0.3 |
| 7d | Complete Artificials (II.) with 5% Nitrogen | 1.0 | — | 0.4 | — | — | — | 0.1 | — | 1.3 | 0.6 | — | 0.3 |
| J8a | Complete Artificials (II.) without Potash | 1.0 | — | 0.4 | — | — | — | — | — | 1.3 | 0.4 | — | — |
| 8b | Complete Artificials (II.) with 2½% Potash | 1.0 | — | 0.4 | — | — | — | — | — | 1.3 | 0.4 | — | 0.2 |
| 8c | Complete Artificials (II.) with 5% Potash | 1.0 | — | 0.4 | — | — | — | — | — | 1.3 | 0.4 | — | 0.3 |
| 8d | Complete Artificials (II.) with 7½% Potash | 1.0 | — | 0.4 | — | — | — | — | — | 1.3 | 0.4 | — | 0.4 |
| K1 | Double Complete Artificials (Formula I.) | 1.0 | — | 0.8 | — | — | — | 0.2 | — | 1.0 | 0.4 | 0.4 | 0.4 |
| K2 | Unmanured | 1.0 | — | — | — | — | — | — | — | — | — | — | — |
| K3 | Complete Artificials (I.) with Standard | 1.0 | 14 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | — | 0.5 | 0.2 | 0.2 | 0.2 |
| K4 | Complete Artificials (I.) with Dung | 1.0 | 7 | 0.4 | — | — | — | 0.1 | — | 0.5 | 0.2 | 0.2 | 0.2 |
| K5 | Complete Artificials (I.) | 1.0 | — | 0.4 | — | — | — | 0.1 | — | 0.5 | 0.2 | 0.2 | 0.2 |
| K6 | Complete Artificials (I.) without Phosphates | 1.0 | — | — | — | — | — | 0.1 | — | — | 0.2 | 0.2 | 0.2 |
| K7 | Complete Artificials (I.) without Nitrogen | 1.0 | — | 0.4 | — | — | — | 0.1 | — | 0.5 | — | — | 0.2 |
| K8 | Complete Artificials (I.) without Potash | 1.0 | — | 0.4 | — | — | — | — | — | 0.5 | 0.2 | 0.2 | — |

* The top-dressing is applied in eight equal instalments.

**(c) Series M. Variety Trials.**

In these trials, which were begun in 1923, new varieties are tested against old varieties of established commercial excellence.

Radio and Ailsa Craig gave the highest yields of 43.93 and 43.63 tons per acre respectively, with a slightly greater proportion of "Pinks" and "Pinks and Whites" in favour of Ailsa Craig. Masterpiece yielded 41.27 tons per acre, but the fruit was of poor quality. This variety is remarkably short jointed and is worth a trial in pots in small houses.

## Manurial Treatment of Series M.

**Base Manure.**

1 lb. Lime per sq. yd.
14 lbs. Stable Manure per sq. yd.
¾ lb. per sq. yd. of the following mixture:—
1 part Bone Meal.
1 part Bone Flour.
1 part Hoof and Horn.
1 part Sulphate of Potash.

**Top-dressing.**

Mulch of Stable Manure.
Eight dressings, each consisting of 2 ozs. per sq. yd. of the following mixture:—
3 parts Sulphate of Ammonia.
2 parts Dried Blood.
7 parts 30% Superphosphate.
5 parts Pure Dissolved Bones.
½ part Bone Flour.
2½ parts Sulphate of Potash.

The results are summarised in Table XXXIX. and detailed in Tables XL. to LV.

**Table XXXIX. Variety Trials.**

| VARIETY. | Lbs. per Plant. | Tons per Acre. |
|---|---|---|
| Radio ... ... ... ... | 5.78 | 43.93 |
| Ailsa Craig ... ... ... | 5.74 | 43.63 |
| Masterpiece ... ... ... | 5.43 | 41.27 |
| Pale Blako ... ... ... | 5.23 | 39.75 |
| Ailsa Craig x Manx Marvel ... | 5.22 | 39.67 |
| Tuckswood ... ... ... | 5.05 | 38.33 |
| Comet ... ... ... ... | 4.88 | 37.10 |
| Best of All ... ... ... | 4.83 | 36.67 |

## Table XL.

**M1. Variety—"Pale Blako."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.30 | .82 | .44 | .14 | .09 | 2.79 | 21.20 | 53.33 |
| B. | — | .31 | .39 | .43 | .15 | .03 | 1.31 | 9.96 | 25.06 |
| C. | — | .30 | .34 | .14 | .02 | — | .80 | 6.08 | 15.30 |
| D. | — | .01 | .03 | .07 | .03 | .02 | .16 | 1.22 | 3.07 |
| E. | — | .01 | .05 | .07 | — | — | .13 | .99 | 2.49 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .02 | — | .02 | — | .04 | .30 | .75 |
| Total | — | 1.93 | 1.65 | 1.15 | .36 | .14 | 5.23 | 39.75 | 100 |

## Table XLI.

**M2. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.69 | 1.51 | .42 | .29 | .16 | 4.07 | 30.94 | 73.23 |
| B. | — | .33 | .41 | .28 | .10 | .12 | 1.24 | 9.42 | 22.29 |
| C. | — | .02 | .11 | .01 | — | — | .14 | 1.06 | 2.51 |
| D. | — | — | .01 | .02 | .02 | .01 | .06 | .46 | 1.08 |
| E. | — | .01 | .01 | .01 | — | — | .03 | .23 | .54 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | .01 | — | — | .02 | .15 | .35 |
| Total | — | 2.05 | 2.06 | .75 | .41 | .29 | 5.56 | 42.26 | 100 |

## Table XLII.

**M3. Variety—"Ailsa Craig x Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.12 | 1.01 | .41 | .14 | .16 | 2.84 | 21.58 | 55.14 |
| B. | — | .27 | .56 | .28 | .14 | .12 | 1.37 | 10.41 | 26.61 |
| C. | — | .28 | .34 | .05 | .01 | — | .68 | 5.16 | 13.18 |
| D. | — | .01 | .07 | .08 | .01 | .01 | .18 | 1.37 | 3.51 |
| E. | — | — | .01 | .02 | — | — | .03 | .23 | .59 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .03 | — | — | .02 | .05 | .38 | .97 |
| Total | — | 1.68 | 2.02 | .84 | .30 | .31 | 5.15 | 39.13 | 100 |

## Table XLIII.

**M4. Variety—"Comet."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.11 | 1.07 | .36 | .16 | .14 | 2.84 | 21.58 | 55.89 |
| B. | — | .13 | .13 | .06 | .02 | .14 | .48 | 3.65 | 9.45 |
| C. | — | .49 | .82 | .30 | .05 | .01 | 1.67 | 12.69 | 32.87 |
| D. | — | — | .03 | .02 | .02 | — | .07 | .54 | 1.40 |
| E. | — | .01 | — | .01 | — | — | .02 | .15 | .39 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | — | — | — | — | — |
| Total | — | 1.74 | 2.05 | .75 | .25 | .29 | 5.08 | 38.61 | 100 |

## Table XLIV.

**M5. Variety—"Best of All."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.18 | 1.31 | .40 | .12 | .11 | 3.12 | 23.71 | 58.32 |
| B. | — | .10 | .37 | .18 | .07 | .11 | .83 | 6.31 | 15.52 |
| C. | — | .48 | .48 | .19 | .03 | — | 1.18 | 8.96 | 22.04 |
| D. | — | — | .02 | .06 | .02 | — | .10 | .77 | 1.89 |
| E. | — | — | .01 | .07 | — | — | .08 | .61 | 1.50 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .02 | .02 | — | — | .04 | .30 | .73 |
| Total | — | 1.76 | 2.21 | .92 | .24 | .22 | 5.35 | 40.66 | 100 |

## Table XLV.

**M6. Variety—"Masterpiece."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .98 | .65 | .21 | .08 | .18 | 2.10 | 15.96 | 40.47 |
| B. | — | .55 | .65 | .53 | .16 | .14 | 2.03 | 15.43 | 39.11 |
| C. | — | .36 | .30 | .10 | .01 | — | .77 | 5.85 | 14.84 |
| D. | — | .03 | .02 | .12 | .01 | — | .18 | 1.37 | 3.46 |
| E. | — | — | .02 | .04 | — | — | .06 | .46 | 1.16 |
| F. | — | .01 | — | — | — | — | .01 | .08 | .20 |
| G. | — | — | .03 | — | — | .01 | .04 | .30 | .76 |
| Total | — | 1.93 | 1.67 | 1.00 | .26 | .33 | 5.19 | 39.45 | 100 |

## Table XLVI.

**M7. Variety—"Radio."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.38 | 1.46 | .47 | .25 | .13 | 3.69 | 38.04 | 64.39 |
| B. | — | .37 | .44 | .38 | .19 | .12 | 1.50 | 11.40 | 26.17 |
| C. | — | .06 | .20 | .04 | — | .01 | .31 | 2.36 | 5.42 |
| D. | — | — | .01 | .08 | .04 | .01 | .14 | 1.06 | 2.43 |
| E. | — | — | — | .03 | — | — | .03 | .23 | .53 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .04 | .01 | — | — | .06 | .46 | 1.06 |
| Total | — | 1.82 | 2.15 | 1.01 | .48 | .27 | 5.73 | 43.55 | 100 |

## Table XLVII.

**M8. Variety—"Tuckswood."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.01 | 1.19 | .38 | .26 | .12 | 2.96 | 22.50 | 56.53 |
| B. | — | .25 | .38 | .23 | .10 | .12 | 1.08 | 8.20 | 20.60 |
| C. | — | .53 | .41 | .05 | .04 | — | 1.03 | 7.82 | 19.64 |
| D. | — | — | — | .03 | .01 | — | .04 | .30 | .76 |
| E. | — | — | .07 | .02 | .02 | — | .11 | .83 | 2.09 |
| F. | — | — | — | — | — | — | -- | — | — |
| G. | — | — | — | .01 | — | .01 | .02 | .15 | .38 |
| Total | — | 1.79 | 2.05 | .72 | .43 | .25 | 5.24 | 39.80 | 100 |

## Table XLVIII.

**M11. Variety—"Pale Blako."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .58 | .94 | .62 | .10 | .10 | 2.34 | 17.78 | 44.74 |
| B. | — | .21 | .35 | .37 | .14 | .06 | 1.13 | 8.59 | 21.61 |
| C. | — | .54 | .62 | .21 | .01 | — | 1.38 | 10.49 | 26.38 |
| D. | — | .02 | — | .04 | .04 | .02 | .12 | .91 | 2.29 |
| E. | — | — | .03 | .13 | — | — | .16 | 1.22 | 3.07 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .09 | — | — | — | .10 | .76 | 1.91 |
| Total | — | 1.36 | 2.03 | 1.37 | .29 | .18 | 5.23 | 39.75 | 100 |

## Table XLIX.

**M12. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.23 | 2.17 | .40 | .23 | .15 | 4.18 | 31.77 | 70.63 |
| B. | — | .28 | .45 | .40 | .21 | .13 | 1.47 | 11.17 | 24.82 |
| C. | — | .02 | .04 | — | .01 | — | .07 | .53 | 1.18 |
| D. | — | — | — | .05 | .03 | — | .08 | .61 | 1.35 |
| E. | — | — | .03 | .07 | — | — | .10 | .76 | 1.69 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | .01 | .01 | — | .02 | .15 | .33 |
| Total | — | 1.53 | 2.69 | .93 | .49 | .28 | 5.92 | 44.99 | 100 |

## Table L.

**M13. Variety—"Ailsa Craig x Manx Marvel."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.23 | 1.63 | .48 | .21 | .12 | 3.67 | 27.89 | 69.36 |
| B. | — | .41 | .42 | .26 | .17 | .14 | 1.40 | 10.64 | 26.46 |
| C. | — | .05 | .05 | .02 | — | — | .12 | .91 | 2.26 |
| D. | — | — | .01 | .02 | .02 | .01 | .06 | .46 | 1.14 |
| E. | — | — | — | .01 | — | — | .01 | .08 | .20 |
| F. | — | .01 | — | .01 | — | — | .02 | .15 | .38 |
| G. | — | — | .01 | — | — | — | .01 | .08 | .20 |
| Total | — | 1.70 | 2.12 | .80 | .40 | .27 | 5.29 | 40.21 | 100 |

## Table LI.

**M14. Variety—"Comet."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .96 | 1.20 | .39 | .17 | .11 | 2.83 | 21.51 | 60.60 |
| B. | — | .04 | .28 | .11 | .05 | .06 | .54 | 4.10 | 11.55 |
| C. | — | .39 | .56 | .24 | .01 | .01 | 1.21 | 9.20 | 25.92 |
| D. | — | — | — | .04 | — | .01 | .05 | .38 | 1.07 |
| E. | — | — | .01 | .01 | — | — | .02 | .15 | .43 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | — | — | .01 | .02 | .15 | .43 |
| Total | — | 1.39 | 2.06 | .79 | .23 | .20 | 4.67 | 35.49 | 100 |

## Table LII.

**M15. Variety—"Best of All."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .82 | 1.40 | .39 | .09 | .05 | 1.75 | 13.29 | 40.66 |
| B. | — | .11 | .22 | .19 | .03 | .06 | .61 | 4.64 | 14.20 |
| C. | — | .60 | .81 | .16 | .02 | — | 1.59 | 12.09 | 36.98 |
| D. | — | — | .01 | .04 | — | .02 | .07 | .53 | 1.63 |
| E. | — | — | .05 | .05 | — | — | .10 | .76 | 2.33 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .03 | .01 | — | .13 | .18 | 1.37 | 4.20 |
| Total | — | 1.54 | 2.52 | .84 | .14 | .26 | 4.30 | 32.68 | 100 |

## Table LIII.

**M16. Variety—"Masterpiece."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.15 | .82 | .26 | .14 | .33 | 2.70 | 20.52 | 47.62 |
| B. | — | .51 | .44 | .36 | .15 | .29 | 1.75 | 13.29 | 30.84 |
| C. | — | .25 | .61 | .08 | .02 | — | .96 | 7.30 | 16.93 |
| D. | — | .01 | .05 | .06 | .04 | .01 | .17 | 1.29 | 3.00 |
| F. | — | — | .02 | .06 | — | — | .08 | .61 | 1.42 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | — | — | — | .01 | .08 | .19 |
| Total | — | 1.92 | 1.95 | .82 | .35 | .63 | 5.67 | 43.09 | 100 |

## Table LIV.

**M17. Variety—"Radio."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.55 | 1.74 | .46 | .11 | .24 | 4.10 | 31.17 | 70.36 |
| B. | — | .40 | .49 | .26 | .10 | .17 | 1.43 | 10.86 | 24.51 |
| C. | — | .01 | .07 | .04 | .01 | — | .13 | .99 | 2.24 |
| D. | — | — | — | .07 | .01 | .01 | .09 | .68 | 1.53 |
| E. | — | — | .02 | .02 | — | — | .04 | .30 | .67 |
| F. | — | .01 | — | — | — | — | .01 | .08 | .18 |
| G. | — | — | .02 | .01 | — | — | .03 | .23 | .51 |
| Total | — | 1.97 | 2.34 | .86 | .24 | .42 | 5.83 | 44.31 | 100 |

## Table LV.

**M18. Variety—"Tuckswood."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.16 | 1.19 | .41 | .17 | .10 | 3.03 | 23.02 | 62.47 |
| B. | — | .31 | .24 | .17 | .10 | .08 | .90 | 6.86 | 18.62 |
| C. | — | .32 | .29 | .10 | .02 | .01 | .74 | 5.62 | 15.25 |
| D. | — | — | .01 | .02 | .03 | — | .06 | .45 | 1.22 |
| E. | — | — | .02 | .02 | — | — | .04 | .30 | .81 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .06 | .01 | .01 | — | — | .08 | .60 | 1.63 |
| Total | — | 1.85 | 1.76 | .73 | .32 | .19 | 4.85 | 36.85 | 100 |

**Investigations concerning the reduction in yield of the tomato crop resulting from continuous cultivation on the same soil.**

These investigations were begun in 1923, when four new tomato houses were erected at the Station. At the outset the soil was made uniform to a depth of two feet and the turf was dug in. Three houses were well manured, while one received no manurial treatment, the plants being dependent for their food on that existing in the soil or arising from the decomposition of the turf. One quarter of a manured house and one quarter of the unmanured house was allowed to remain fallow during the first season, 1923. In 1924 the treatments were repeated and half of each fallow portion was cropped.

In 1923 the manured houses produced 55.8, 55.2 and 51 tons per acre, while the untreated house gave 32.3 tons per acre. The same houses in 1924 gave 52.3, 50.38 and 49.78 tons per acre for the manured houses and 25.55 tons per acre in the unmanured house. It will be seen that the yield during the second year was lower than that of the first year of cultivation.

The fallowing of the land during 1923 proved beneficial in both the manured and the unmanured houses, especially in the latter, where the result is very striking.

In the manured house, the plots fallow during 1923 gave an average of 55.52 tons per acre as against 52.30 tons per acre from plots cultivated during 1923 and 1624. In the unmanured house the plots fallow in 1923 produced an average crop of 46.36 tons per acre as against 25.55 tons per acre from the rest of the house.

The results obtained during 1924 suggested that the large crop from plots which had lain fallow for one year, was due to the decomposition of the turf dug into the soil in 1923, and the consequent building up and accumulation of plant foods.

Assuming the beneficial action of decayed turf, it seemed desirable to ascertain if any portion of the turf is more valuable than another. For this purpose a quantity of good turf was obtained, and from it the plant portion was carefully extracted. Two plots, O7 and Q10, each 25 ft. by 6 ft., were given 6 cwts. of turf plants; two plots, O2 and Q2, of a similar size were each given 5½ cwts. turf ash obtained by slowly burning 6 cwts. of turf plants; while two plots, O3 and Q8, were each given 2 cwts. of fresh grass cuttings. The applications were made on December 19th, 1924, and only half of each plot was planted, the other remaining fallow during 1925. The plots in Series O were also manured in the usual way, while

Series Q remained unmanured as in the previous two years. Two plots in Series N were set apart to test the effect of dressings of magnesium salts. Plot N3 received ½ oz. magnesium carbonate per sq. yd. in the first top-dressing, while plot N9 received a similar dressing of magnesium sulphate.

Plot N4, fallow during 1923, was planted in 1924 and again in 1925. Plot N6, fallow during 1923 and 1924, was planted during 1925, while plot N7, fallow in 1923, and planted in 1924, was left fallow again during 1925.

In the unmanured Series Q, plot Q4, fallow in 1923, and planted in 1924, was again planted during 1925. Plot Q6, fallow 1923 and 1924, was planted in 1925, while plot Q7, fallow in 1923, planted in 1924, remained fallow during 1925, Also one half of plot Q3, which was planted in 1923 and 1924. was left fallow during 1925.

The results of these experiments are interesting. The yield from each plot, with the exception of N9, O2, O3, Q2 and Q8, was less during 1925 than in previous years. The plot receiving magnesium carbonate is no exception, but that receiving magnesium sulphate showed a higher yield in 1925 than in previous years. This result must be tested further. In 1924 plot Q4, which remained fallow during 1923, gave a crop equal to 50 tons per acre. This year, plot Q6, fallow for two years, yielded only 42 tons per acre. This difference may be a seasonal variation, and only further experiment will prove its significance.

The high yield of 70 tons per acre has been obtained from plot N6. This plot has been fallow for two years, but has received the same manures as the remainder of the plots in Series N. This result must be tested further, but at this stage it suggests a new method of manuring tomatoes. The effect of this experiment has been to enrich the soil of this plot and presumably to convert the added fertilisers into a state in which they are easily assimilated by plants. **It suggests better results from manuring with compost heaps in which the necessary fertilisers have been added many months previously, than from applying the crude fertilisers directly to the growing crop.**

The plots treated with turf plants, turf ash and grass cuttings have also given important results.

The turf plants given to O7 and Q10 have not appreciably affected the crop this year, for the yield was less than in 1924, but it is possible that an increase may be shown next year when the fallow halves of the plots are planted.

On the other hand, plots O2 and Q2 to which turf ash was applied have benefited from the treatment. In plot O2 the yield is only slightly higher than in 1924, but in Q2 the increase is much greater. **Probably the most striking result is that obtained by adding grass cuttings. In both cases, plots O3 and Q8, this treatment has raised the crop almost to the first year's standard.**

Such results are satisfactory for they indicate the benefits to be derived from green manuring and point the way to a line of experimentation which should prove of considerable value to cultivators of glasshouse plants. The results are given in Tables LVI. to LXXXVI.

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**Table LVI.**

**N1. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.03 | 1.05 | .35 | .25 | .52 | 3.20 | 24.32 | 55.27 |
| B. | — | .24 | .32 | .14 | .09 | .28 | 1.07 | 8.13 | 18.48 |
| C. | — | .03 | .18 | .05 | .05 | .01 | .32 | 2.43 | 5.52 |
| D. | — | — | — | .02 | .02 | .05 | .09 | .68 | 1.55 |
| E. | — | — | .09 | .02 | — | — | .11 | .84 | 1.91 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .27 | .50 | .12 | .01 | .10 | 1.00 | 7.60 | 17.27 |
| Total | — | 1.57 | 2.14 | .70 | .42 | .96 | 5.79 | 44.00 | 100 |

## Table LVII.

**N2. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.37 | 1.09 | .36 | .22 | .52 | 3.56 | 27.08 | 59.39 |
| B. | — | .27 | .36 | .12 | .08 | .32 | 1.15 | 8.74 | 19.16 |
| C. | — | — | .15 | .07 | .07 | — | .29 | 2.19 | 4.80 |
| D. | — | .02 | .01 | .01 | — | .05 | .09 | .68 | 1.49 |
| E. | — | — | .05 | .02 | — | — | .07 | .53 | 1.16 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .21 | .44 | .13 | .01 | .05 | .84 | 6.38 | 13.09 |
| Total | — | 1.87 | 2.10 | .71 | .38 | .94 | 6.00 | 45.60 | 100 |

## Table LVIII.

**N3. Magnesium Carbonate. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.37 | 1.04 | .38 | .26 | .59 | 3.64 | 27.67 | 55.51 |
| B. | — | .31 | .38 | .13 | .07 | .36 | 1.25 | 9.50 | 19.05 |
| C. | — | .03 | .12 | .08 | .03 | .03 | .29 | 2.20 | 4.41 |
| D. | — | — | .02 | .01 | — | .06 | .09 | .68 | 1.36 |
| E. | — | .03 | .05 | .07 | — | — | .15 | 1.14 | 2.29 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .25 | .63 | .13 | .05 | .08 | 1.14 | 8.66 | 17.38 |
| Total | — | 1.99 | 2.24 | .80 | .41 | 1.12 | 6.56 | 49.85 | 100 |

## Table LIX.

**N4. Fallow 1923, Cropped 1924 and 1925.**

**Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.20 | 1.06 | .46 | .41 | .91 | 4.04 | 30.70 | 55.33 |
| B. | — | .32 | .21 | .09 | .05 | .42 | 1.09 | 8.28 | 14.92 |
| C. | — | .10 | .11 | .10 | .07 | .03 | .41 | 3.12 | 5.62 |
| D. | — | — | — | .02 | — | .14 | .16 | 1.22 | 2.20 |
| E. | — | — | .03 | .09 | — | — | .12 | .92 | 1.66 |
| F. | — | — | — | .03 | — | — | .03 | .23 | .41 |
| G. | — | .12 | .95 | .21 | .06 | .11 | 1.45 | 11.02 | 19.86 |
| Total | — | 1.74 | 2.36 | 1.00 | .59 | 1.61 | 7.30 | 55.49 | 100 |

## Table LX.

**N6. Fallow 1923 and 1924, Cropped 1925.**

**Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.01 | 1.28 | 1.10 | .18 | .94 | 5.51 | 41.86 | 59.77 |
| B. | — | .41 | .31 | .16 | .06 | .46 | 1.40 | 10.64 | 15.19 |
| C. | — | .15 | .55 | .31 | .01 | .50 | 1.52 | 11.55 | 16.48 |
| D. | — | .09 | — | .01 | — | .10 | .20 | 1.52 | 2.17 |
| E. | — | — | .04 | .11 | — | .03 | .18 | 1.37 | 1.96 |
| F. | — | .02 | — | — | — | — | .02 | .15 | .21 |
| G. | — | .10 | .13 | .13 | — | .03 | .39 | 2.96 | 4.22 |
| Total | — | 2.78 | 2.31 | 1.82 | .25 | 2.06 | 9.22 | 70.07 | 100 |

## Table LXI.

**N8. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.51 | .82 | .75 | .32 | .62 | 5.02 | 38.16 | 68.89 |
| B. | — | .44 | .24 | .21 | .09 | .41 | 1.39 | 10.56 | 19.06 |
| C. | — | .09 | .12 | .10 | .06 | .06 | .43 | 3.27 | 5.90 |
| D. | — | .02 | — | .02 | — | .05 | .09 | .68 | 1.23 |
| E. | — | .07 | .02 | .03 | — | — | .12 | .91 | 1.64 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .13 | .09 | — | .01 | .24 | 1.82 | 3.28 |
| Total | — | 3.14 | 1.33 | 1.20 | .47 | 1.15 | 7.29 | 55.40 | 100 |

## Table LXII.

**N9. Magnesium Sulphate. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.20 | .80 | .72 | .20 | .60 | 4.52 | 34.34 | 63.54 |
| B. | — | .57 | .28 | .20 | .09 | .40 | 1.54 | 11.70 | 21.65 |
| C | — | .15 | .15 | .11 | .07 | .05 | .53 | 4.05 | 7.50 |
| D. | — | .02 | .01 | .02 | — | .03 | .08 | .61 | 1.13 |
| E. | — | .05 | .03 | .01 | — | — | .09 | .68 | 1.26 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .03 | .18 | .07 | .01 | .06 | .35 | 2.66 | 4.92 |
| Total | — | 3.02 | 1.45 | 1.13 | .37 | 1.14 | 7.11 | 54.04 | 100 |

## Table LXIII.

**N10.**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.88 | .93 | .50 | .15 | .38 | 3.84 | 29.18 | 65.31 |
| B. | — | .50 | .29 | .14 | .10 | .25 | 1.28 | 9.73 | 21.78 |
| C. | — | .07 | .06 | .08 | .02 | .04 | .27 | 2.05 | 4.59 |
| D. | — | — | .03 | .02 | .02 | .03 | .10 | .76 | 1.70 |
| E. | — | — | .02 | .07 | — | — | .09 | .68 | 1.52 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .09 | .13 | .04 | .02 | .02 | .30 | 2.28 | 5.10 |
| Total | — | 2.54 | 1.46 | .85 | .31 | .72 | 5.88 | 44.68 | 100 |

## Table LXIV.

**O1. Variety—"Ailsa Craig,"**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.67 | .72 | .56 | .23 | .56 | 3.74 | 28.42 | 64.59 |
| B. | — | .50 | .29 | .17 | .05 | .31 | 1.32 | 10.04 | 22.81 |
| C. | — | .11 | .18 | .06 | .04 | .04 | .43 | 3.27 | 7.43 |
| D. | — | .02 | .02 | .03 | — | .04 | .11 | .83 | 1.89 |
| E. | — | .03 | .01 | .02 | — | — | .06 | .45 | 1.02 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .08 | .02 | — | .02 | .13 | .99 | 2.26 |
| Total | — | 2.34 | 1.30 | .86 | .32 | .97 | 5.79 | 44.00 | 100 |

## Table LXV.

**O2a. Turf Ash.**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.50 | .77 | .63 | .20 | .64 | 3.74 | 28.43 | 61.12 |
| B. | — | .64 | .30 | .22 | .10 | .32 | 1.58 | 12.00 | 25.85 |
| C. | — | .04 | .09 | .13 | .05 | .09 | .40 | 3.04 | 6.54 |
| D. | — | — | .04 | .06 | — | .04 | .14 | 1.06 | 2.27 |
| E. | — | .05 | .04 | .05 | — | — | .14 | 1.06 | 2.27 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .03 | .05 | — | .02 | .02 | .12 | .91 | 1.95 |
| Total | — | 2.26 | 1.29 | 1.09 | .37 | 1.11 | 6.12 | 46.50 | 100 |

## Table LXVI.

**O3a. Grass.** **Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.10 | .92 | .61 | .47 | .68 | 4.78 | 36.34 | 64.37 |
| B. | — | .62 | .33 | .16 | .06 | .34 | 1.51 | 11.47 | 20.31 |
| C. | — | .27 | .20 | .12 | .05 | .05 | .69 | 5.24 | 9.28 |
| D. | — | .06 | .04 | .06 | .02 | .04 | .22 | 1.67 | 2.96 |
| E. | — | .03 | .04 | .02 | — | — | .09 | .68 | 1.20 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .07 | .07 | — | — | — | .14 | 1.06 | 1.88 |
| Total | — | 3.15 | 1.60 | .97 | .60 | 1.11 | 7.43 | 56.46 | 100 |

## Table LXVII.

**04. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.63 | .72 | .75 | .25 | .74 | 4.09 | 31.09 | 64.62 |
| B. | — | .48 | .25 | .23 | .05 | .38 | 1.39 | 10.56 | 21.96 |
| C. | — | .12 | .10 | .11 | .07 | .06 | .46 | 3.50 | 7.28 |
| D. | — | .01 | .03 | .02 | .02 | .05 | .13 | .99 | 2.06 |
| E. | — | .01 | .04 | .07 | — | — | .12 | .91 | 1.88 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .08 | .05 | — | — | .14 | 1.06 | 2.20 |
| Total | — | 2.26 | 1.22 | 1.23 | .39 | 1.23 | 6.33 | 48.11 | 100 |

## Table LXVIII.

**05. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.83 | .82 | .54 | .35 | .71 | 4.25 | 32.29 | 72.52 |
| B. | — | .47 | .32 | .16 | .04 | .33 | 1.32 | 10.03 | 22.52 |
| C. | — | .02 | .06 | .01 | .01 | .03 | .13 | .99 | 2.22 |
| D. | — | .02 | .01 | .03 | — | .03 | .09 | .68 | 1.53 |
| E. | — | .02 | — | .01 | — | — | .03 | .23 | .52 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .03 | — | — | — | .04 | .30 | .69 |
| Total | — | 2.37 | 1.24 | .75 | .40 | 1.10 | 5.86 | 44.52 | 100 |

## Table LXIX.

**O6. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.02 | .75 | .58 | .38 | .66 | 4.39 | 33.35 | 71.25 |
| B. | — | .61 | .35 | .15 | .06 | .31 | 1.48 | 11.24 | 24.02 |
| C. | — | — | .02 | .01 | .03 | .02 | .08 | .60 | 1.28 |
| D. | — | .02 | .02 | .05 | — | .03 | .12 | .92 | 1.97 |
| E. | — | .03 | — | — | — | — | .03 | .23 | .49 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .02 | .01 | .01 | .01 | .01 | .06 | .46 | .99 |
| Total | — | 2.70 | 1.15 | .80 | .48 | 1.03 | 6.16 | 46.80 | 100 |

## Table LXX.

**O7a. Turf. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.00 | .89 | .70 | .30 | .60 | 4.40 | 33.41 | 70.60 |
| B. | — | .47 | .28 | .16 | .06 | .39 | 1.36 | 10.33 | 21.83 |
| C. | — | .07 | .03 | — | — | .01 | .11 | .83 | 1.75 |
| D. | — | .02 | — | .02 | — | .06 | .10 | .76 | 1.61 |
| E. | — | .01 | — | .02 | — | — | .03 | .23 | .49 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .02 | .13 | .03 | — | .05 | .23 | 1.75 | 3.72 |
| Total | — | 2.59 | 1.24 | .93 | .36 | 1.11 | 6.23 | 47.31 | 100 |

## Table LXXI.

**O8. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.86 | .80 | .73 | .22 | .59 | 4.20 | 31.90 | 68.06 |
| B. | — | .32 | .24 | .11 | .04 | .30 | 1.01 | 7.68 | 16.40 |
| C. | — | .19 | .21 | .11 | .01 | .11 | .63 | 4.79 | 10.21 |
| D. | — | .02 | .09 | .03 | .01 | .05 | .20 | 1.52 | 3.24 |
| E. | — | .02 | — | — | — | — | .02 | .15 | .32 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .06 | .04 | — | — | .11 | .83 | 1.77 |
| Total | — | 2.42 | 1.40 | 1.02 | .28 | 1.05 | 6.17 | 46.87 | 100 |

## Table LXXII.

**P1. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.73 | .88 | .45 | .31 | .66 | 4.03 | 30.61 | 71.55 |
| B. | — | .31 | .26 | .09 | .07 | .30 | 1.03 | 7.83 | 18.31 |
| C. | — | .05 | .05 | .03 | .01 | .04 | .18 | 1.37 | 3.20 |
| D. | — | .02 | .03 | .03 | .01 | .04 | .12 | .91 | 2.13 |
| E. | — | .02 | .02 | .01 | — | — | .05 | .38 | .89 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .08 | .10 | .03 | .01 | — | .22 | 1.67 | 3.92 |
| Total | — | 2.21 | 1.33 | .64 | .41 | 1.04 | 5.63 | 42.77 | 100 |

## Table LXXIII.

**P2. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.16 | .91 | .60 | .31 | .70 | 4.68 | 35.55 | 73.00 |
| B. | — | .42 | .31 | .13 | .06 | .29 | 1.21 | 9.20 | 18.89 |
| C. | — | .03 | .07 | .02 | .01 | .01 | .14 | 1.06 | 2.18 |
| D. | — | .05 | .03 | .02 | .02 | .03 | .15 | 1.14 | 2.34 |
| E. | — | .02 | .01 | — | — | — | .03 | .23 | .47 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .08 | .08 | .03 | — | .01 | .20 | 1.52 | 3.12 |
| Total | — | 2.76 | 1.41 | .80 | .40 | 1.04 | 6.41 | 48.70 | 100 |

## Table LXXIV.

**P3. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 2.05 | .79 | .43 | .30 | .82 | 4.39 | 33.37 | 70.23 |
| B. | — | .50 | .30 | .14 | .09 | .39 | 1.42 | 10.80 | 22.73 |
| C. | — | .03 | .03 | .02 | .02 | — | .10 | .76 | 1.60 |
| D. | — | .04 | .02 | .03 | .01 | .04 | .14 | 1.06 | 2.23 |
| E. | — | .04 | — | — | — | — | .04 | .30 | .63 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .06 | .09 | .01 | — | — | .16 | 1.22 | 2.58 |
| Total | — | 2.72 | 1.23 | .63 | .42 | 1.25 | 6.25 | 47.51 | 100 |

## Table LXXV.

**P4. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.55 | .95 | .45 | .30 | .72 | 3.97 | 30.17 | 69.88 |
| B. | — | .42 | .28 | .16 | .06 | .39 | 1.31 | 9.96 | 23.07 |
| C. | — | .02 | .05 | .04 | .02 | — | .13 | .99 | 22.29 |
| D. | — | .02 | — | .04 | — | .04 | .10 | .76 | 1.76 |
| E. | — | .02 | — | — | — | — | .02 | .15 | .35 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .01 | .10 | .01 | .02 | .01 | .15 | 1.14 | 2.65 |
| Total | — | 2.04 | 1.38 | .70 | .40 | 1.16 | 5.68 | 43.17 | 100 |

## Table LXXVI.

**P5. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.36 | .95 | .53 | .21 | .70 | 3.75 | 28.50 | 66.95 |
| B. | — | .42 | .29 | .15 | .05 | .32 | 1.23 | 9.35 | 21.97 |
| C | — | .05 | .08 | .05 | — | .07 | .25 | 1.90 | 4.47 |
| D. | — | .02 | .02 | .07 | .02 | .05 | .18 | 1.37 | 3.23 |
| E. | — | .02 | .02 | .01 | — | — | .05 | .38 | .89 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .05 | .08 | .01 | — | — | .14 | 1.06 | 2.49 |
| Total | — | 1.92 | 1.44 | .82 | .28 | 1.14 | 5.60 | 42.56 | 100 |

## Table LXXVII.

**P6. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.82 | .83 | .60 | .12 | 1.00 | 4.37 | 33.21 | 70.36 |
| B. | — | .40 | .30 | .16 | .05 | .33 | 1.24 | 9.43 | 19.98 |
| C. | — | .05 | .08 | .03 | .01 | .03 | .20 | 1.52 | 3.22 |
| D. | — | — | .06 | .05 | .02 | .02 | .15 | 1.14 | 2.42 |
| E. | — | .06 | .01 | — | — | — | .07 | .53 | 1.12 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .06 | .07 | .03 | — | .02 | .18 | 1.37 | 2.90 |
| Total | — | 2.39 | 1.35 | .87 | .20 | 1.40 | 6.21 | 47.20 | 100 |

## Table LXXVIII.

**P7. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.64 | .95 | .50 | .35 | .87 | 4.31 | 32.77 | 65.22 |
| B. | — | .45 | .41 | .16 | .07 | .45 | 1.54 | 11.70 | 23.29 |
| C. | — | .05 | .06 | .07 | .03 | .08 | .29 | 2.21 | 4.40 |
| D. | — | .03 | .03 | .04 | .03 | .04 | .17 | 1.29 | 2.57 |
| E. | — | .04 | — | .06 | — | — | .10 | .76 | 1.52 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .06 | .08 | .04 | .01 | .01 | .20 | 1.50 | 3.00 |
| Total | — | 2.27 | 1.53 | .87 | .49 | 1.45 | 6.61 | 50.23 | 100 |

## Table LXXIX.

**P8. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | 1.37 | 1.08 | .40 | .57 | .87 | 4.29 | 32.60 | 65.58 |
| B. | — | .49 | .40 | .13 | .14 | .41 | 1.57 | 11.94 | 24.02 |
| C. | — | .03 | .13 | .02 | .03 | .02 | .23 | 1.75 | 3.52 |
| D. | — | .02 | .02 | .01 | .01 | .05 | .11 | .83 | 1.67 |
| E. | — | .04 | .02 | .03 | — | — | .09 | .68 | 1.37 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | .08 | .07 | .04 | .02 | .04 | .25 | 1.90 | 3.84 |
| Total | — | 2.03 | 1.72 | .63 | .77 | 1.39 | 6.54 | 49.70 | 100 |

## Table LXXX.

**Q1. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .43 | .28 | .11 | .03 | .14 | .99 | 7.53 | 32.07 |
| B. | — | .06 | .09 | .09 | .02 | .10 | .36 | 2.74 | 11.67 |
| C. | — | — | .12 | — | — | — | .12 | .91 | 3.88 |
| D. | — | — | — | — | — | .04 | .04 | .30 | 1.28 |
| E. | — | .90 | .39 | .23 | .02 | .02 | 1.56 | 11.85 | 50.48 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | — | .02 | .02 | .15 | .62 |
| Total | — | 1.39 | .88 | .43 | .07 | .32 | 3.09 | 23.48 | 100 |

## Table LXXXI.

**Q2a. Turf Ash. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .68 | .36 | .26 | .10 | .18 | 1.58 | 12.01 | 37.99 |
| B. | — | .11 | .20 | .10 | .02 | .09 | .52 | 3.95 | 12.49 |
| C. | — | .02 | .08 | .03 | — | .03 | .16 | 1.22 | 3.88 |
| D. | — | — | — | .01 | — | .06 | .07 | .53 | 1.69 |
| E. | — | .96 | .44 | .27 | .07 | .05 | 1.79 | 13.61 | 42.99 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | .01 | .03 | .04 | .30 | .96 |
| Total | — | 1.77 | 1.08 | .67 | .20 | .44 | 4.16 | 31.62 | 100 |

## Table LXXXII.

**Q3b. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .54 | .32 | .17 | .05 | .05 | 1.13 | 8.59 | 34.03 |
| B. | — | .06 | .12 | .07 | .04 | .05 | .34 | 2.59 | 10.26 |
| C. | — | — | — | .01 | — | .03 | .04 | .30 | 1.19 |
| D. | — | — | — | — | — | .02 | .02 | .15 | .59 |
| E. | — | 1.17 | .41 | .18 | — | .02 | 1.78 | 13.54 | 53.64 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .01 | — | — | — | .01 | .07 | .29 |
| Total | — | 1.77 | .86 | .43 | .09 | .17 | 3.32 | 25.24 | 100 |

## Table LXXXIII.

**Q4. Fallow 1923, Cropped 1924 and 1925.**

**Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .34 | .51 | .14 | .12 | .22 | 1.33 | 10.10 | 26.37 |
| B. | — | .12 | .17 | .10 | .04 | .18 | .61 | 4.63 | 12.08 |
| C. | — | — | .14 | .08 | — | .06 | .28 | 2.13 | 5.56 |
| D. | — | — | — | .01 | — | .13 | .14 | 1.06 | 2.77 |
| F. | — | 1.14 | 1.00 | .30 | .03 | .17 | 2.64 | 20.08 | 52.43 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | — | .04 | .04 | .30 | .79 |
| Total | — | 1.60 | 1.82 | .63 | .19 | .80 | 5.04 | 38.30 | 100 |

## Table LXXXIV.

**Q6. Fallow 1923 and 1924, Cropped 1925.**

**Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .39 | .51 | .33 | .17 | .36 | 1.76 | 13.38 | 31.54 |
| B. | — | .05 | .23 | .16 | .09 | .18 | .71 | 5.40 | 12.73 |
| C. | — | — | .17 | .07 | — | .17 | .41 | 3.12 | 7.36 |
| D. | — | — | — | .04 | — | .16 | .20 | 1.52 | 3.58 |
| E. | — | .72 | 1.08 | .34 | .12 | .17 | 2.43 | 18.47 | 43.53 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | .02 | .01 | — | .04 | .07 | .53 | 1.26 |
| Total | — | 1.16 | 2.01 | .95 | .38 | 1.08 | 5.58 | 42.42 | 100 |

## Table LXXXV.

**Q8a. Grass.** **Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .46 | .49 | .17 | .14 | .06 | 1.32 | 10.04 | 33.61 |
| B. | — | .12 | .10 | .18 | .03 | .10 | .53 | 4.03 | 13.49 |
| C. | — | .09 | — | — | — | .02 | .11 | .83 | 2.78 |
| D. | — | — | — | — | — | .06 | .06 | .45 | 1.51 |
| E. | — | .90 | .57 | .28 | .04 | .07 | 1.86 | 14.14 | 47.34 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | — | .05 | .05 | .38 | 1.27 |
| Total | — | 1.57 | 1.16 | .63 | .21 | .36 | 3.93 | 29.87 | 100 |

## Table LXXXVI.

**Q9. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .28 | .10 | .08 | .03 | .04 | .53 | 4.02 | 28.39 |
| B. | — | .06 | .01 | .05 | .01 | .05 | .18 | 1.37 | 9.69 |
| C. | — | — | — | — | — | .01 | .01 | .08 | .57 |
| D. | — | — | — | — | — | .03 | .03 | .23 | 1.63 |
| E. | — | .83 | .19 | .06 | — | .03 | 1.11 | 8.44 | 59.72 |
| F. | — | — | — | — | — | — | — | — | — |
| G. | — | — | — | — | — | — | — | — | — |
| Total | — | 1.17 | .30 | .19 | .04 | .16 | 1.86 | 14.14 | 100 |

**Table LXXXVII.**

**Q10a. Turf. Variety—"Ailsa Craig."**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | — | .79 | .24 | .15 | .06 | .07 | 1.31 | 9.96 | 40.09 |
| B. | — | .11 | .04 | .15 | .01 | .06 | .37 | 2.81 | 11.31 |
| C. | — | — | — | — | — | .06 | .06 | .45 | 1.81 |
| D. | — | — | — | — | .01 | .03 | .04 | .30 | 1.21 |
| E. | — | .70 | .38 | .26 | .04 | .08 | 1.46 | 11.10 | 44.66 |
| F. | — | — | .03 | — | — | — | .03 | .23 | .92 |
| G. | — | — | — | — | — | — | — | — | — |
| Total | — | 1.60 | .69 | .56 | .12 | .30 | 3.27 | 24.85 | 100 |

## Manurial Treatment of Series N, O and P.

**Base Manure.**

1 lb. Lime.
14 lbs. Stable Manure.
¼ lb. Bone Meal.
¼ lb. Bone Flour.
¼ lb. Sulphate of Potash.

**Top-dressing.**

Mulch of Stable Manure.

Eight dressings, each consisting of 2 ozs. per sq. yd. of the following mixture:—

6 parts Meat Meal.
8 parts Dissolved Bones.
3 parts Sulphate of Potash.
2 parts Bone Meal.
1 part Sulphate of Ammonia.

This gave 5% Ammonia, 24% Total Phosphates, 12% Soluble Phosphates and 7% Potash on examination.

## Cucumber Experiments.

The present series of experiments which were started in 1922 for the purpose of studying the various depressing factors present in cucumber bases, have been continued.

Plot 2 in House D, which showed a crop increase of 35% after steaming in 1922, was left untreated in 1923 and it was found that the benefits resulting from steaming the base did not persist for a second season. In 1924 the base was again steamed, and while the resulting crop was greater than that of the control plot, the increase was not so great as in 1922. In the winter 1924-25 the base was again steamed, but the steaming was carried out only fourteen days before introducing the beds. By this means it was hoped that additional benefits would result from the higher soil temperature at the time of planting. The resulting crop of 1.9 flats per foot (63.64 lbs. per plant) justified the cost of steaming. It shows an increase of 24% over the control. Plot D5, in which the base was also steamed gave two flats per foot or an increase of 32% over the control.

The discrepancy between the results obtained by steaming the base during 1922, 1924 and 1925 afford indications that the benefits to be derived from steaming the base are affected considerably by the weather during February and March. When this is favourable the cucumber is able to profit from the sterilised soil, and make a good start. In unfavourable weather there is less benefit, and in some cases the crop is actually retarded in the early stages.

As steaming the base showed such excellent results in 1922 the experiment was extended in 1924. For this purpose House C was divided into four plots, in two of which (C1 and C3) the base was steamed, while the remainder (C2 and C4) ½ cwt. of horse manure and ½ cwt. cow manure was applied to each nine feet of border and dug in prior to steaming. The results obtained in 1924 showed an increase of 17% in favour of manuring and steaming. The experiment was repeated in 1925, and the crop from the manured and steamed base was only 2% greater than that from the base which was steamed without addition of manure.

The contradictory nature of the results seem to indicate that the application of manure to the base before steaming is an unnecessary expense.

A further development in 1925 was the application of ½ cwt. of horse manure and ½ cwt. of cow manure to the base of plot D1, after it had been steamed. The result was distinctly bad,

for the crop was 23% less than that of the control. A result of this nature was not unexpected, because steamed soil is the "happy hunting ground" of organisms introduced after the soil has cooled. The organisms introduced in the cow and horse manure might be expected to thrive in the sterilised soil and so set up conditions harmful to plant roots.

The experiments with plants grown in beds over concrete in Houses D and E were continued.

At the beginning of these experiments it was thought that an increased crop would result from the use of any mechanical device which would prevent the roots of the cucumber plants from coming into contact with the infected base. In 1922 the yield from the plants in these beds over concrete approximated to that of the control, and it was thought that the beds were too small for the roots. In 1923 larger beds were used, but still the yield was neither greater nor less than that of the control. In 1924 the concrete surface was divided into two equal portions by constructing a wall running east and west. The south half was infected by covering the concrete with a three inch layer of soil from an old base, while in the case of the north half the surface of the concrete was sterilised by means of formaldehyde and a painter's blow lamp, before introducing the beds. Special care was taken throughout the season to prevent the beds on the north half of the concrete from being infected with material from the base. The purpose of this experiment was to test the validity of the assumption that the depressing factor in the base is highly infectious and had been introduced unknowingly into previous experimental beds where no special precautions had been taken to prevent it. The crop yield from both sections were very similar and no further light was thrown on the problem.

During 1925, the experiment was continued in the following manner. The beds used in 1924 were not removed from the concrete, but were spread over it at the end of the season. The beds covering the two south plots were untreated, while those over the north plots were steamed *in situ*. The beds for 1925 were prepared by introducing fresh stable manure but no new soil. Later in the season the plants on all four plots were given a handful of new soil round the collar at the time of top dressing. The results are striking, an average of 1.29 flats per foot (42.73 lbs. per plant) being obtained from the untreated old beds, and 1.9 flats per foot (62.74 lbs. per plant) from the old beds steamed.

In another plot, E1, the composition of the bed was varied to allow increased aeration. It was prepared of one part loam, one part ashes and one part stable manure, instead of two

parts loam and one part stable manure. Although the base was untreated the plot gave the high yield of 1.9 flats per foot (64.14 lbs. per plant).

What may ultimately prove to be one of the best experiments in this series, was arranged for plot F2. During 1924 plots F1 and F2 became infected with eelworm, and gave a very poor crop. At the end of 1924, the beds were taken away, and the base excavated to a depth of eighteen inches. The sides and bottom of the resulting trench were thoroughly steamed and the trench filled up with ashes in F1 and with a poor gravel soil in F2. Normal beds were used over these bases. The base of ashes has given 1.64 flats per foot (54.36 lbs. plant), while the poor gravel base has given two flats per foot (66.48 lbs. per plant).

Probably the ashes are too porous during the first year, and may be better when the finer soil particles have been washed down into them from the bed. The gravel base is very promising because the plants remained vigorous to the end.

The remaining plots 3 to 6 in House F were treated as follows. The beds used during 1923 were spread and steamed *in situ* for 1924. At the end of 1924 they were again spread and divided into four plots. Mustard was sown on plots F3 and F5 in October. A good growth was obtained and on December 12th the plants were dug into the soil. Fourteen days before planting, plots F5 and F6 were steamed.

The resulting yields were 1.3 flats per foot (42.92 lbs. per plant) where mustard was dug into the soil, F3, and 1.16 flats per foot (36.47 lbs. per plant) in the control, F4. Plot F5, where the beds were steamed after digging in the mustard, gave 1.99 flats per foot (65.69 lbs. per plant) while the steamed bed, F6, gave 1.61 flats per foot (59.88 lbs. per plant). It will be seen that the mustard increased the yield in each case.

## Summary of Results, 1922–1925.

Several important facts have emerged from these experiments, and may be summarised as follows:—

(1) When the cucumber is grown in a bed of loam and stable manure for one complete season, the bed is rendered unsuitable for cucumber cultivation during the following season.

(2) The continuous cultivation of the cucumber in beds placed over the same soil for a number of years contaminates the base. The actual process of contamination is not understood, but it seems reasonable to suppose that the contamination is washed down from the beds and accumulates in the base.

(3) When the roots of cucumber plants come in contact with the contaminated base their health and fruiting powers are seriously impaired.

(4) Sterilisation of a contaminated base by means of steam causes a marked improvement in crop and presumably removes the base contamination.

(5) The beneficial effects of steaming last for one year only, and therefore in old soil it is necessary to steam every year.

(6) The degree of improvement in the crop which results from steaming the base is affected by the nature of the weather during the early stages of growth. When the weather is favourable, the plant's increased vitality enables it to make full use of the sterilised soil. During unfavourable weather, the plants do not make such a good start and in some cases sterilisation of the base has caused a slight retardation of growth in the early stages.

(7) It seems advisable to delay steaming the base as long as possible, so as to take advantage of planting in warmed soil.

(8) By spreading and steaming the beds at the end of the season, a higher crop has been obtained under the Experimental Station conditions than by removing the old beds and substituting new compost.

(9) The replacement of a contamined base by new soil of a poor gravel nature caused an immediate improvement in crop this year, and the plants retained their vigour to the end of the season.

(10) A crop of practically two flats per foot has been obtained over a concrete covered base, when the bed was sufficiently big, namely, the previous year's bed spread and steamed.

(11) The admixture of washed ashes in the beds this year was an advantage.

(12) Finally, the cucumber plant requires a well-aerated bed and a well-drained base, if it is to yield the best crop.

**Table LXXXVIII.**

Showing the composition of the beds, and the top-dressing treatment employed in the cucumber experiments in Houses C, D, E and F.

| Plots. | Beds. | Top-dressing | |
|---|---|---|---|
| | | 1st dressing March 14th | Remaining dressings March 21st to September 22nd |
| D3, D4, E3, E4, F3, F6. | Beds used in 1924 with 50 % stable manure added | Loam and stable manure with 14lbs. bone meal to every 100 ft. of border | Loam and stable manure with 14 lbs. fertiliser as given in Tomato Series G., H. and M. to every 100 ft. of border |
| E1. | 1 part loam, 1 part washed ashes, 1 part stable manure | as above | as above |
| All remaining plots. | 2 parts loam and 1 part stable manure composted in Novbr. | as above | as above |

## Table LXXXIX.

| Plot. | Treatment. | Lbs. per Plant. | | | | | | | | Tons per Acre. | Flats per Foot. | Relative Value | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mar. | April. | May. | June. | July. | Aug. | Sept. | Total. | | | | |
| C1. | Base steamed ... ... ... ... | 1.66 | 13.60 | 10.71 | 8.88 | 8.59 | 9.35 | 5.10 | 57.89 | 86.84 | 1.75 | 112 | 112 |
| C3. | ,, ,, ... ... ... ... | 0.93 | 11.31 | 13.00 | 8.99 | 10.60 | 8.72 | 4.10 | 57.65 | 86.48 | 1.74 | 112 | |
| C2. | Base manured, then steamed ... ... | 1.14 | 12.76 | 12.16 | 8.16 | 9.22 | 8.48 | 5.20 | 57.12 | 85.68 | 1.73 | 111 | 114 |
| C4. | ,, ,, ,, ,, ... ... | 1.99 | 12.05 | 10.90 | 9.25 | 12.81 | 9.18 | 4.20 | 60.38 | 90.57 | 1.83 | 117 | |
| D1. | Base steamed, then manured ... ... | 1.41 | 8.39 | 8.01 | 6.65 | 7.65 | 3.85 | 3.60 | 39.56 | 59.34 | 1.20 | 77 | |
| D2. | Base steamed ... ... ... ... | 2.74 | 12.90 | 12.70 | 8.65 | 10.75 | 10.30 | 5.60 | 63.64 | 95.46 | 1.93 | 124 | |
| D3. | Concrete, last year's bed ... .. | 1.35 | 6.47 | 8.72 | 7.34 | 9.00 | 8.26 | 3.60 | 44.74 | 67.11 | 1.35 | 86 | 83 |
| E3. | ,, ,, ,, ,, ... ... | 1.27 | 6.42 | 8.49 | 8.04 | 6.85 | 6.09 | 3.60 | 40.72 | 61.08 | 1.23 | 79 | |
| D4. | Concrete, last year's bed steamed ... | 2.56 | 10.17 | 11.95 | 9.67 | 9.20 | 9.79 | 7.00 | 60.34 | 90.51 | 1.83 | 117 | 122 |
| E2. | ,, ,, ,, ,, ,, ... | 2.35 | 11.55 | 12.12 | 10.47 | 11.38 | 10.76 | 6.50 | 65.13 | 97.70 | 1.97 | 126 | |
| D5. | Base steamed ... ... ... ... | 1.45 | 12.62 | 11.38 | 9.07 | 12.10 | 13.08 | 8.40 | 68.10 | 102.15 | 2.06 | 132 | |
| E1. | Base untreated bed, 1 loam, 1 ashes, 1 dung ... ... ... ... ... | 2.40 | 13.44 | 11.06 | 9.23 | 9.70 | 11.31 | 7.00 | 64.14 | 96.21 | 1.94 | 124 | |
| E4. | Base untreated ... ... ... ... | 1.73 | 11.64 | 9.98 | 6.71 | 7.94 | 8.83 | 4.70 | 57.53 | 77.30 | 1.56 | 100 | |
| E5. | ,, ,, ... ... ... ... | 2.64 | 12.76 | 10.94 | 9.09 | 6.80 | 8.38 | 3.90 | 54.51 | 81.77 | 1.65 | 105 | |
| F1. | Ashes base ... ... ... ... ... | 2.38 | 11.60 | 9.67 | 9.01 | 7.31 | 8.49 | 5.90 | 54.36 | 81.54 | 1.64 | 105 | |
| F2. | Gravel base ... ... ... ... ... | 1.35 | 13.96 | 12.02 | 10.47 | 9.53 | 11.05 | 8.10 | 66.48 | 99.72 | 2.01 | 129 | |
| F3. | Mustard ... ... ... ... ... | 0.37 | 3.56 | 8.31 | 8.70 | 6.70 | 9.88 | 5.40 | 42.92 | 69.38 | 1.30 | 83 | |
| F4. | Untreated ... ... ... ... ... | 0.54 | 4.39 | 6.89 | 8.31 | 7.54 | 6.30 | 4.50 | 38.47 | 57.71 | 1.16 | 74 | |
| F5. | Mustard, steamed ... ... ... ... | 0.93 | 12.83 | 12.38 | 10.35 | 9.34 | 11.66 | 8.20 | 68.69 | 98.54 | 1.99 | 128 | |
| F6. | Steamed ... ... ... ... ... | 0.84 | 10.94 | 10.94 | 10.24 | 6.66 | 10.71 | 7.60 | 59.88 | 89.82 | 1.81 | 115 | |

## Soil Sterilisation Experiments.

Further experiments in soil sterilisation were possible through the kindness of Mr. C. H. Shoults, who placed a house at our disposal. This house was divided into twelve plots, each 30 ft. by 13 ft. Five plots were untreated controls, and the remaining seven received dressings of certain chemical sterilising agents. Details of treatments and results are given in Table LXXXIX. None of the compounds tested produced a marked increase in crop yield.

By the kindness of Mr. J. Harnett details were given in the Tenth Annual Report of certain sterilisation experiments which he carried out in 1924. These experiments have been continued during 1925 with interesting results.

In 1924, a block of houses, the soil of which had not been sterilised previously and in which tomatoes had been cultivated during twelve years, was set apart for this experiment. The soil of fifteen houses was steamed by the grid method to a depth of eighteen inches; four houses were treated with 97—99% cresylic acid at the rate of one gallon over 9 sq. yds.; whilst two were left as controls. The control houses produced 28 tons per acre, those treated with cresylic acid 43 tons per acre; whilst the steamed houses yielded 50.25 tons per acre.

During 1925, those houses steamed in 1924 were left untreated, and the yield fell from 50.25 tons per acre to 40 tons per acre. The houses which were untreated during 1924 were steamed, and the crop rose from 28 tons per acre to 51 tons per acre, which is very close to the 50.25 tons per acre obtained by steaming in 1924.

The houses treated with cresylic acid in 1924 were steamed in 1925 and the crop increased from 43 tons per acre to 59 tons per acre. This high yield obtained by steaming the year following treatment with cresylic acid is interesting and opens up possibilities of combining chemical sterilisation and heat sterilisation. The treatments and resulting crops are shown in Table XC.

## Table LXXXIX.

| Plot. | TREATMENT. | Lbs. per Plant. | | | | | | Total Tons per Acre. | Relative. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | June. | July. | Aug. | Sept. | Oct. | Total. | | | |
| 2 | Control ... ... ... ... ... ... ... | 0.57 | 2.36 | 0.54 | 0.52 | 1.11 | 5.10 | 38.76 | 106 | |
| 3 | Control ... ... ... ... ... ... ... | 0.64 | 2.03 | 0.49 | 0.53 | 1.18 | 4.87 | 37.01 | 101 | |
| 5 | Control ... ... ... ... ... ... ... | 0.71 | 1.87 | 0.60 | 0.47 | 1.18 | 4.83 | 36.81 | 101 | 100 |
| 9 | Control ... ... ... ... ... ... ... | 0.73 | 1.81 | 0.61 | 0.39 | 0.99 | 4.53 | 34.43 | 94 | |
| 12 | Control ... ... ... ... ... ... ... | 0.41 | 2.22 | 0.70 | 0.47 | 0.88 | 4.68 | 35.57 | 97 | |
| 1 | 3 lbs. Potassium dichlorphenate per 43 sq. yds. ... | 0.43 | 2.65 | 0.60 | 0.51 | 1.02 | 5.21 | 39.60 | 108 | |
| 10 | 3 lbs. Potassium dichlorphenate per 43 sq. yds. ... | 0.73 | 2.07 | 0.56 | 0.43 | 0.94 | 4.73 | 35.92 | 98 | 103 |
| 4 | 3 lbs. Potassium dichlorcresylate per 43 sq. yds. ... | 0.62 | 1.96 | 0.57 | 0.49 | 1.13 | 4.77 | 36.25 | 99 | |
| 7 | 3 lbs. Potassium dichlorcresylate per 43 sq. yds. ... | 0.99 | 1.96 | 0.64 | 0.41 | 1.15 | 5.15 | 39.14 | 107 | 103 |
| 6 | 40 galls. Cheshunt Compound per 43 sq. yds.... ... | 0.94 | 2.13 | 0.54 | 0.52 | 1.33 | 5.46 | 41.50 | 114 | |
| 11 | 40 galls. Cheshunt Compound per 43 sq. yds.... ... | 0.57 | 2.05 | 0.66 | 0.44 | 0.92 | 4.64 | 35.26 | 97 | 106 |
| 8 | 3½ galls. cresylic acid per 43 sq. yds. ... ... ... | 0.80 | 1.89 | 0.59 | 0.39 | 0.99 | 4.53 | 34.43 | 94 | |

**Table XC.**

| Year. | Section. | Treatment. | Tons per Acre. | Relative. |
|---|---|---|---|---|
| 1924 | A. | Steam ... ... ... ... | 50.25 | 180 |
| | B. | Cresylic acid ... ... ... | 43 | 154 |
| | C. | Other liquid sterilisers ... ... | 33 | 114 |
| | D. | Control ... ... ... ... | 28 | 100 |
| 1925 | A. | Untreated (steamed 1924) ... | 40 | 143 |
| | B. | Steam (cresylic 1924) ... ... | 59 | 210 |
| | D. | Steam (control 1924) ... ... | 51 | 182 |

# Mycological Investigations.

During the past year the mycological investigations have included the *Phytophthora* disease of cucumber seedlings, the *Thielavia* disease of beans and tomatoes and *Tomato Mildew*. The Director has continued his investigation of Mosaic disease.

Diseases brought to the station, not previously reported are listed below.

| Host. | Disease. | Parasite. |
|---|---|---|
| Aster ... ... | ... Wilt ... | ... *Cephalosporium Asteris* |
| Celery ... ... | ... Soft rot | ... *B. carotovorus* |
| French bean ... | ... Root rot | ... *Thielavia basicola* |
| Mushroom ... | ... —— | ... *Monilia fimicola* |
| Narcissus ... | ... Bacterial rot | ... Organism not identified |
| Rose ... ... | ... Canker | ... *Coniothyrium Fuckelii* |
| *Solanum capsicastrum* | ... *Oedema* | ... Physiological disorder |
| Tomato ... ... | ... Root rot | ... *Thielavia basicola* |
| Vine ... ... | ... Canker | ... *Rhabdospora sp.* |

## Tomato Leaf Mould.

P. H. Williams.

The most important disease of the tomato in this country is that known to nurserymen as " Mildew." The term " Mildew " is unfortunate, as most mildews are whitish in appearance and a more suitable name is " Leaf mould," for diseased leaves possess a typical mouldy appearance.

The disease, which is caused by a fungus, *Cladosporium fulvum*, first appears as a pale olive-buff downy growth in local spots on the under surface of the leaf. Later the growth changes colour, passing through tawny-olive to purple. Looking at the leaf from above, it will be seen that the tissue above a fungus spot is at first pale yellow in colour, passing through deep ochre-yellow to reddish brown as the disease progresses.

Leaf mould is transmitted from infected to healthy plants by means of spores carried by air-currents, but the source of the original infection in the spring is still unknown. No host plants, other than the tomato, have been found for this disease, and no over-wintering forms have been described.

The present experiments have been designed to obtain information concerning the process of infection.

**Spore Dispersal.**

A diseased leaf was placed under a bell jar about six inches above a set of vaselined slides. These were examined at 12 hour intervals and it was found that under these conditions the spores remained on the pustule, as only a few were caught on the slides. A leaf was placed vertically in a box in the bottom of which a hole had been cut. Slides were so fixed in the upper part of the box, that their vaselined surfaces would catch any spores carried upward and currents were induced by a small burner placed underneath. Even when a fairly vigorous current of air was driven through the box by this means, no spores were caught during four hours.

The flame was removed and a strong current of air was blown through the hole by means of bellows. By this means spores were detached and caught on the slides. Possibly, therefore, the spores found on the slides in the first experiment were accidentally shaken off in moving the bell jar. The spores appear to stick tightly together, since they have always been observed in clumps. It would therefore appear that moderately strong air currents or leaf movements are necessary to dislodge the spores from the pustules, and that the principal cause of the dispersal of spores is shaking of the plants by the workers and by strong winds.

**Germination of the Spores.**

The time required for the germination of the spores under different conditions has been studied. The spores were derived from cultures on starch-agar isolated originally in July, 1924. Hanging drop cultures were prepared and examined at intervals. The optimum temperature for germination was found to lie between 26°C. (79°F.) and 27°C. (81°F.) while at 32°C. (90°F.) germination rarely took place. A summary of results follows.

Number of hours taken for germination to start at different temperatures.

| Temperature in Degrees Centigrade. | Medium. | Hours. 1 | 2 | 3 | 4 | 5 | 6 | 24 | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 18.5°—24.0° ... | Water | — | — | — | + | + | + | + | In the light |
| 19.0°—21.5° ... | ,, | — | — | + | + | + | + | + | ,, ,, |
| 21.0°—25.5° ... | ,, | — | — | — | + | + | + | + | ,, ,, |
| 21.0° ... ... ... | ,, | — | — | — | + | + | + | + | In darkness |
| 21.0° ... ... ... | ,, | — | — | — | + | + | + | + | ,, ,, |
| 21.0° ... ... ... | ,, | — | — | — | + | + | + | + | ,, ,, |
| 21.0° ... ... ... | ,, | — | — | + | + | + | + | + | ,, ,, |
| 26.0° ... ... ... | ,, | — | — | — | + | + | + | + | ,, ,, |
| 26.0° ... ... ... | ,, | — | — | + | + | + | + | + | ,, ,, |
| 26.0° ... ... ... | ,, | — | — | + | + | + | + | + | ,, ,, |
| 26.0° ... ... ... | ,, | — | — | + | + | + | + | + | ,, ,, |
| 26.0°—28.0° ... | ,, | — | — | + | + | + | + | + | ,, ,, |
| 27.0°—28.5° ... | ,, | — | + | + | + | + | + | + | ,, ,, |
| 28.0°—32.0° ... | ,, | — | — | — | + | + | + | + | ,, ,, |
| 30.0° ... ... ... | ,, | — | — | — | + | + | + | + | ,, ,, |
| 32.0° ... ... ... | ,, | — | — | — | + | + | + | + | ,, ,, |
| 32.0° ... ... ... | ,, | — | — | — | — | — | + | + | ,, ,, |
| 32.0° ... ... ... | ,, | — | — | — | — | — | — | — | ,, ,, |
| 32.0° ... ... ... | ,, | — | — | — | — | — | + | + | ,, ,, |

— = no germination. + = germination.

**Penetration of the Leaf by the Germ Tube.**

(1) Drops of a spore suspension were placed within circles of Indian ink on the leaves of plants, which were then placed under a bell jar. A piece of leaf containing one of these spots was cut off at intervals and cleared by fixing in 10 per cent. hydrochloric acid and treating with chloral hydrate and potassium hydroxide. In many cases no trace of the fungus could be seen, and it is probable that in the numerous changes of solution and especially in the preliminary fixing the spores were washed off, since no appressoria are formed. By this method germination but no penetration was observed in 26 hours.

(2) Leaves were infected as before and pieces of the epidermis were stripped off and examined at intervals. No penetration was observed in 39 hours. It would therefore appear that a long period elapses before penetration takes place. This is in accordance with the results of other workers on this and other leaf parasites. This work is being continued.

**Effect of certain Compounds on the Fungus.**

(1) The effect of certain compounds on *Cladosporium fulvum* was determined by adding their solutions to liquid cultures of the organism. The method employed was as follows :—Four cubic centimeters of Czapek's culture solution were measured into tubes and sterilised. 1 cc. of the appropriate solution at five times the required strength was then added under aseptic

conditions. This course was adopted to avoid changes in the medium as a result of heating. Even so, precipitates were frequently produced, especially in the case of sulphur compounds. Five tubes were allotted to each substance examined. One of these served as control, while to the remaining four the substance was added. Three of those were inoculated, the fourth serving to test the possibility of contamination. The following compounds were tested :—Liver of sulphur, lime sulphur, sodium polysulphide, " Cheshunt compound," copper silico-fluoride, manganese silico-fluoride, barium silico-fluoride, and nickel silico-fluoride.

Each substance was used at various strengths. In no case did the fungus grow in the treated tubes, while all the controls grew well.

(2) To simulate the conditions obtained on a sprayed leaf, drops of the solution to be tested were allowed to dry on a sterile cover-slip. Each slip was then inoculated with a suspension of spores and inverted on a hanging drop slide, germination being watched under the microscope. After two or three days, germination had taken place in the control drops and it was possible to determine the action of the fungicide. The results are summarised below :—

| | |
|---|---|
| Suspension of sulphur ... ... ... ... | No germination |
| Colloidal sulphur ... ... ... ... | ,, ,, |
| Sodium polysulphide 2.5% ... ... ... | ,, ,, |
| ,, ,, 1.0% ... ... ... | Germination |
| ,, ,, 0.5% ... ... ... | ,, |
| Lime sulphur 2.0% ... ... ... ... | ,, |
| ,, ,, 1.0% ... ... ... ... | ,, |
| ,, ,, 0.5% ... ... ... ... | ,, |
| Liver of sulphur 0.5% ... ... ... ... | No Germination |
| Ammonium polysulphide 0.5% ... ... | ,, ,, |
| Cheshunt compound 2.0% ... ... ... | ,, ,, |
| ,, ,, 1.0% ... ... ... | ,, ,, |
| ,, ,, 0.5% ... ... ... | ,, ,, |
| Copper silico-fluoride 0.5% ... ... ... | ,, ,, |
| ,, ,, 0.2% ... ... ... | ,, ,, |
| Nickel silico-fluoride 0.5% ... ... ... | ,, ,, |
| Barium silico-fluoride (sat. solution) ... ... | ,, ,, |

**The effect of certain Sprays on Tomato Foliage.**

For this purpose young tomato plants and shoots were sprayed with various compounds to determine the highest strength at which no scorching occurred. The results are given below :—

| Spray used. | Material sprayed. | Result. |
|---|---|---|
| Milton 20% ... ... ... ... ... | Plants | Scorch |
| ,, 15% ... ... ... ... ... | ,, | ,, |
| ,, 10% ... ... ... ... ... | ,, | ,, |
| ,, 5% ... ... ... ... ... | ,, | Slight scorch |
| ,, 4% ... ... ... ... ... | ,, | No scorch |
| ,, 3% ... ... ... ... ... | ,, | ,, |
| ,, 2% ... ... ... ... ... | ,, | ,, |
| ,, 1% ... ... ... ... ... | ,, | ,, |

| Spray used. | | Material sprayed. | Result. |
|---|---|---|---|
| Copper silico-fluoride | 0.5% | Shoots | Scorch |
| ,, ,, | 0.25% | ,, | ,, |
| Nickel silico-fluoride | 2.5% | ,, | ,, |
| ,, ,, | 1.25% | ,, | ,, |
| ,, ,, | 0.5% | ,, | ,, |
| Barium silico-fluoride, saturated solution | | ,, | ,, |
| Sodium polysulphide | 2.5% | ,, | Slight scorch |
| ,, ,, | 1.0% | ,, | No scorch |
| ,, ,, | 0.5% | ,, | ,, |
| Cheshunt compound | 5.0% | Plants | Slight scorch |
| ,, ,, | 2.5% | ,, | Very slight scorch |
| ,, ,, | 1.0% | ,, | No scorch |
| ,, ,, | 0.5% | ,, | ,, |
| Ammonium polysulphide | 2.0% | ,, | ,, |
| ,, ,, | 1.5% | ,, | ,, |
| ,, ,, | 1.0% | ,, | ,, |
| ,, ,, | 0.5% | ,, | ,, |
| Chloramine T. | 1.0% | ,, | ,, |
| ,, | 0.5% | ,, | ,, |
| Lime sulphur | 2.0% | ,, | ,, |
| ,, | 1.0% | ,, | ,, |
| ,, | 0.5% | ,, | ,, |
| Liver of Sulphur | 2.0% | ,, | Scorch |
| ,, ,, | 1.0% | ,, | ,, |
| ,, ,, | 0.5% | ,, | No scorch |

**Effect of certain Sprays and Dusts on the Spore Pustule.**

Following these experiments affected leaves were sprayed or dusted and placed under a bell jar. After 18-24 hours spores were removed and plated on potato agar. A large number of the compounds listed above were tested, but in no case was the fungus killed. This is probably due to the difficulty of wetting the leaf and also to the peculiar growth of the spore masses. As mentioned above the spores adhere together and the outermost tend to protect those within from the action of the fungicide. In experiments carried out in the houses it was found that the dusts would not stick unless they were actually blown against the pustule. Even where the dust was so fine as to penetrate throughout the block of houses an effective covering was not obtained.

**Effect of Sulphur Dioxide and Formaldehyde on the Fungus.**

With a view to the destruction of the fungus at the end of the season experiments on the effect of the above compounds have been carried out. Both have been recommended by pathologists but the high cost of formaldehyde and the large amount of sulphur required have prevented their universal adoption. Our experiments, however, indicate that the amount of sulphur recommended is excessive.

**Sulphur Dioxide.**

(*a*) Cultures were exposed to varying concentrations of sulphur dioxide for different lengths of time. Small pieces were then removed and placed on the surface of a plate of potato agar.

The sulphur dioxide was generated by decomposing the theoretical amount of sodium bisulphite with excess of sulphuric acid. In all cases the culture turned yellow and the aerial hyphae collapsed. At concentrations from 100 per cent. to 6.25 per cent. with an exposure of two hours, the fungus was killed.

(*b*) An affected leaf was placed in a glass jar and exposed to the required concentration of sulphur dioxide for thirty minutes. Spores were then removed and plated. The spore masses turned a bright yellow colour at concentrations above 5 per cent. and no growth was subsequently obtained. The lethal concentration appears to lie around 1 per cent. so far as can be judged from the apparatus used, which was of necessity somewhat crude This is roughly equivalent to burning 2 lbs. of sulphur per 1,000 cu. ft.

**Formaldehyde.**

A piece of culture was placed in a sterile petri dish, the lid of which was raised on corks. This was placed under a bell jar together with a watch glass containing 40 per cent. formaldehyde. Pieces of culture were removed at intervals and placed on the surface of a plate of agar.

26 hours' exposure—no growth.
18 ,, ,, ,, ,,
4 ,, ,, ,, ,,
3 ,, ,, ,, ,,
2 ,, ,, ,, ,,
1 ,, ,, ,, ,,

Spores from a leaf treated in a similar manner gave no germination after eight hours.

## "Damping off" of Cucumber Seedlings.

P. H. Williams.

" Damping off " and " foot-rot " of young tomato plants was investigated in 1919 ; an account being published in the Annual Report. Two species of the fungus *Phytophthora, P. parasitica* and *P. cryptogea* were found to be responsible for most of the damage. The former fungus was also found to cause an important disease of tomato fruits, known as " Buck-eye Rot."

A " damping off " disease of cucumber, caused by a different species of *Phytophthora* has been known for some time, but the fungus has not been studied in detail.

**Phytophthora Diseases of Tomatoes and Cucumbers.**

A case of wholesale destruction of cucumber seedlings was reported in July and the fungus isolated from diseased specimens is being compared under various conditions with a species of *Phytophthora* isolated from tomato seedlings about the same time. So far it has only produced bodies which appear to be oospores, so that its identity is uncertain, but it exhibits peculiarities in its behaviour which distinguish it from the tomato fungus.

**Pathogenicity.**

Three boxes of sterilised soil were prepared and in each fifty cucumber seeds were sown. Box I served as control, box II was inoculated with the fungus by placing pieces of a pure culture in the soil, and box III was similarly inoculated after the young plants were up. In the control forty-two seeds germinated after five days, while at the same time only nineteen were up in box II. Only two of these remained healthy after three days. Examination showed that many of the seeds had germinated but the young plants had rotted before appearing above the soil surface. In the third box " damping off " also occurred, commencing around the points at which the fungus had been inserted in the soil. From the diseased plants in both boxes a fungus was re-isolated which was found to be identical with the original.

While the fungus showed extreme virulence to cucumber seedlings, it does not appear to be pathogenic to older plants. Pot plants showing two rough leaves were inoculated with the fungus just above the soil level, but only slight browning occurred round the point of inoculation. Experiments are now in progress to determine the stage at which the cucumber plant becomes immune to infection.

**Comparative Inoculation Experiments.**

**Effect on Seedlings.**

*P. parasitica* from tomato seedlings was tested for pathogenicity by inoculating boxes of tomato seedlings in sterilised soil. Seventeen days after inoculation the seedlings collapsed and *P. parasitica* was re-isolated.

Boxes of cucumber seedlings in sterilised soil were inoculated with *P. parasitica* from the tomato. No " damping off " occurred up to sixty days.

Similarly, boxes of cucumber seedlings were inoculated with the *Phytophthora*-like fungus isolated from the cucumber, when the disease appeared in five days.

Boxes of tomato seedlings were also inoculated with the cucumber fungus but without effect. These experiments indicate that the *Phytophthora*-like fungus from the cucumber is different from the *Phytophthora* from the tomato.

**Mature Plants.**

*(a) Tomatoes.*

Young pot plants were inoculated just above the soil surface with both fungi. Those inoculated with the tomato fungus showed the typical ring of collapsed tissue after eight days, and the fungus was successfully re-isolated. The cucumber fungus had no effect.

*(b) Cucumbers.*

No infection with either fungus was obtained with pot plants.

**Tomato Fruits.**

Both fungi produce a rot of tomato fruits. That obtained with the cucumber fungus appears to be a more generalised rot, while appearances suggestive of "buck-eye rot" have been observed in the other case. The necessity of keeping the inoculated fruit covered, to prevent contamination, causes the production of aerial hyphæ, which tend to mask any colour changes in the fruit. So far there has been no opportunity of inoculating fruits while still on the plant.

## Root-rot of the Tomato caused by Thielavia basicola

P. H. Williams.

During April, 1925, some wilted tomato plants were examined. The roots were rotted and the interior of the stem was brown. From this material a fungus, *Thielavia basicola*, was isolated. This fungus is known to cause a root rot of tobacco in America and also attacks peas and beans. Less well established is its pathogenicity to the tomato, and the present work is designed to clear up this point, since it has been met with frequently in diseased plants.

Inoculations of young tomato plants with pure cultures of *Thielavia* failed in the spring, and the matter was allowed to rest until recently when it appeared as the cause of a disease of French beans. In this case the disease took the form of a root rot, together with brown spots on the hypocotyl and destruction of the pith to a greater or less degree. In one case the blackened pith was found to be a mass of the winter spores of *Thielavia*. Beans were germinated on blotting paper and

inoculated from a pure culture. In three days, brown streaks were produced half an inch above the point of inoculation, similar to those on the original diseased plants. As *Thielavia* spores were found on the surface of these spots, it was decided to continue the investigation and extend it to the tomato.

**The Fungus.**

*Thielavia* is easily recognisable by its peculiar spore forms. One form, known as the summer-spore, is produced within the fungal threads from which the spores are ejected to form a greyish mass in culture. They are rectangular, 12.3μ by 4.5μ, and have flat ends. The other form, the winter spore, is responsible for the dark colour of diseased tissues. It is club-shaped, black, and divided into several cells by cross walls. It readily breaks up into separate cells, each cell functioning as a separate spore.

**Growth in Pure Culture.**

The rate and character of the growth on various media has been studied. On plant decoctions it grows well, potato agar and Quaker Oat agar being the best, while on tomato agar the growth is slow. On synthetic media growth is very poor, and very few spores of either kind are produced. Work on the rate of growth at different temperatures is still in progress, and it can only be stated that the optimum appears to be about 25°C.

**Inoculation Experiments.**

Towards the end of November young tomato plants were inoculated in the stem with pieces from a pure culture of *Thielavia*. After two weeks a distinct blackening was observed around the point of inoculation and the pith was browned in some cases for a distance of a quarter of an inch. After three weeks the browning had extended in one plant examined to one inch above the prick, and the spores of the fungus were found in the brown tissue. *Thielavia* was re-isolated from this material.

Tobacco plants inoculated in the stem with a pure culture of *Thielavia* showed a distinct browning around the point of inoculation in fourteen days. The pith was browned for a distance of two inches below and one inch above the prick. Wood and cortex were attached to a lesser degree. *Thielavia* was re-isolated from the brown pith.

As mentioned above, inoculations of tomato plants in the spring gave a negative result. It is possible that temperature was the controlling factor, since it has been stated that with the tobacco no infection takes place above 23°C. Experiments to test the truth of this assertion are now in progress.

# "Rhizoctonia foot-rot" of the Tomato.

T. Small.

The following investigation was undertaken on account of the annual losses which certain growers in Guernsey have sustained, as the result of epidemics of "*Rhizoctonia* foot-rot" of young tomato plants.

### The Disease.

The disease appears in the houses shortly after planting, but experiment has shown that much older plants are subject to attack. Dry, brown scars appear on the stem at the region of soil level. Wilting sometimes occurs. When the attack is severe the scars completely encircle the stem, causing the plant to fall over. The disease is contracted from the soil and is caused by a fungus, *Rhizoctonia solani*. This fungus forms very resistant resting bodies called sclerotia, which are difficult to destroy. If not destroyed they are centres of infection when favourable conditions arise.

Experiments have shown that numerous plants, other than the tomato, may be attacked by this fungus.

### Inoculation Experiments.

Young tomato plants in four-inch pots were used.

Inoculations were made by means of small pieces taken from a pure culture of the fungus. In all cases, except those concerned with varietal susceptibility, these pieces of culture were placed in the soil, so that the fungus had to grow through half an inch of soil before reaching the plant. All control plants received a small piece of sterile culture medium, and as they invariably remained healthy throughout the course of these experiments, there is no need to mention them again.

### Varietal Susceptibility.

The following varieties were tested: Radio, Pale Blako, Manx Marvel, Masterpiece, Ailsa Craig, Tuckswood, Comet and Best of All. When grown in soil infected with pure cultures, all the varieties were equally susceptible. The variety Ailsa Craig was chosen for future work.

### Environmental Conditions.

When studying the effect of one particular factor, care was taken to keep all other factors as constant as possible. For purposes of estimating the extent of the disease due to any set of conditions, the following nomenclature was adopted.

I. None.
II. Slight Scars approximately $\frac{1}{4}'' \times \frac{1}{4}''$.
III. Fair Scars approximately $\frac{1}{2}'' \times \frac{1}{4}''$.
IV. Bad Scars approximately $\frac{3}{4}''$ long and passing halfway round the stem.
V. Very bad. Scars one inch or more in length and almost or completely encircling the stem.

**Soil Moisture.**

Plants in four-inch pots were inoculated and placed under the following conditions :—

(*a*) Received no water.
(*b*) Received 100 ccs. water per pot once daily.
(*c*) Received 100 ccs. water per pot twice daily.
(*d*) Stood in a tray containing water.

The results of two experiments are summarised in Table I.

**Table I.**

| Date of inoculation. | Date of observation. | No of plants. | Treatment. | Degree of Attack. None. | Slight. | Fair. | Bad. | Very Bad. |
|---|---|---|---|---|---|---|---|---|
| 28/4/25 | 7/5/25 | 3 | No water | 3 | — | — | — | — |
| 28/4/25 | 7/5/25 | 3 | 100ccs. water per pot once daily | — | — | — | — | 3 |
| 28/4/25 | 7/5/25 | 3 | 100ccs. water per pot twice daily | — | — | — | — | 3 |
| 28/4/25 | 7/5/25 | 3 | Stood in a tray of water | — | — | — | — | 3 |
| 21/5/25 | 27/5/25 | 5 | No water | 1 | 1 | 2 | 1 | — |
| 21/5/25 | 27/5/25 | 5 | 100ccs. water per pot once daily | — | — | — | — | 5 |
| 21/5/25 | 27/5/25 | 5 | 100ccs. water per pot twice daily | 1 | 1 | — | — | 3 |
| 21/5/25 | 27/5/25 | 5 | Stood in a tray of water | 2 | — | 1 | 1 | 1 |

Dryness is obviously beneficial. The results were confirmed in later experiments, combining the effects of soil moisture and air temperature. In addition, experiments comparing clay and sandy soils showed that the former aggravated the disease.

Baked soil contained in a large box with a perforated bottom for drainage purposes, was worked into ridges and furrows. Ten plants were planted on the ridges and ten in the furrows. The whole was then well watered and left for a week, after which the soil was inoculated by means of pieces of pure culture as described previously.

After twelve days the plants were uprooted and examined. All twenty plants were infected, but the degree of infection was greater in the plants situated in the furrows.

In a saturated atmosphere heavier infection occurred than in a well aerated atmosphere. All these experiments proved that the disease is worst in a wet soil.

**Atmospheric Temperature.**

After inoculation the plants were placed in the following positions :—

(*a*) Cucumber house.
(*b*) Tomato house.
(*c*) Glass frame outside.
(*d*) Shaded, glass-covered corridor.

Temperatures were recorded twice daily from thermometers placed among the plants. The night minimum and day maximum were also recorded. In spite of equal watering, the plants in the cucumber house were always more moist than those in the other positions.

The results are shown in Table II.

**Table II.**

| Date of inoculation. | Date of observation. | No. of plants. | Position. | Av. temp. °F. | Degree of Attack. None. | Slight. | Fair. | Bad. | Very Bad. |
|---|---|---|---|---|---|---|---|---|---|
| 27/4/25 | 8/5/25 | 3 | Cucumber house | 77.3 | 2 | 1 | — | — | — |
| 27/4/25 | 8/5/25 | 3 | Tomato house | 68.9 | — | 1 | 2 | — | — |
| 27/4/25 | 8/5/25 | 3 | Frame | 62.5 | — | — | — | 3 | — |
| 27/4/25 | 8/5/25 | 3 | Corridor | 63.1 | — | — | — | — | 3 |
| 18/5/25 | 27/5/25 | 6 | Cucumber house | 83.5 | 5 | 1 | — | — | — |
| 18/5/25 | 27/5/25 | 6 | Tomato house | 72.5 | 2 | — | 1 | 3 | — |
| 18/5/25 | 27/5/25 | 6 | Frame | 68.9 | 3 | — | 1 | 2 | — |
| 18/5/25 | 27/5/25 | 6 | Corridor | 67.3 | 1 | 1 | — | — | 4 |
| 12/11/25 | 19/11/25 | 8 | Tomato house | 60.3 | — | 1 | — | — | 7 |
| 12/11/25 | 19/11/25 | 8 | Corridor | 46.1 | 6 | 2 | — | — | — |
| 21/11/25 | 30/11/25 | 7 | Tomato house | 58.7 | 1 | 1 | — | — | 5 |
| 21/11/25 | 30/11/25 | 7 | Corridor | 44.6 | 7 | — | — | — | — |

These results show that the fungus is injurious over a wide range of temperature, but is markedly injurious between 58.7°F. and 67.3°F.

In pure culture the fungus grows quickest about 78.8°F. and hence the temperatures for maximum pathogenicity and maximum rate of growth in pure culture do not coincide.

Above 72°F., providing the soil was fairly dry, the severity of the attack diminished, whilst above 80°F. very little infection resulted, even when the soil was very moist.

Low glasshouse temperatures would therefore appear to favour the pathogenic action of this fungus. Temperatures around 45°F., where the activity of the fungus is reduced, do not occur in heated glasshouses for any length of time, and therefore control by lowering the temperature to 45°F. is not practical.

**Experiments with Lime.**

Sterilised slaked lime and virgin soil were used. These were thoroughly mixed and the plants potted. After several days the soil was inoculated as described previously. The results of one experiment are shown in Table III.

**Table III.**

| Date of inoculation. | Date of observation. | No. of plants. | Compost. | Result. |
|---|---|---|---|---|
| 25/5/25 | 9/6/25 | 6 | 100% soil | All attacked. |
| 25/5/25 | 9/6/25 | 6 | 0.1% lime | „ |
| 25/5/25 | 9/6/25 | 6 | 0.2% „ | „ |
| 25/5/25 | 9/6/25 | 6 | 0.4% „ | „ |
| 25/5/25 | 9/6/25 | 6 | 1.0% „ | „ |
| 25/5/25 | 9/6/25 | 6 | 5.0% „ | Four attacked. |
| 25/5/25 | 9/6/25 | 6 | 10.0% „ | All attacked. |

Corroborative experiments were made, and of sixteen plants, with as much as 10.0% lime in the soil, only one escaped infection. Applied at the usual rate of one pound per square yard (0.2%) thirty-two plants were tested and 78% infection was established.

Thus under the conditions of the experiment lime did not check the disease.

**Experiments with Stable Manure.**

Sterilised soil and stable manure were used. A few days were allowed to elapse between potting and inoculation. From the results summarised in Table IV. and other similar experiments, it was evident that the addition of even sterilised stable manure aggravated the disease.

**Table IV.**

| Date of inoculation. | Date of observation. | No. of Plants. | Compost. | Degree of attack. None. | Slight. | Fair. | Bad. | Very Bad. |
|---|---|---|---|---|---|---|---|---|
| 5/8/25 | 13/8/25 | 6 | 100% soil | — | — | 3 | 2 | — |
| 5/8/25 | 13/8/25 | 6 | 3.0% manure | — | — | — | — | 6 |
| 5/8/25 | 13/8/25 | 6 | 6.0% ,, | — | — | — | — | 6 |
| 5/8/25 | 13/8/25 | 6 | 12.0% ,, | — | — | 2 | — | 4 |

The fungus grew quite well upon sterile stable manure in a flask. This suggests that stable manure is a possible source of infection.

The conclusions were further confirmed in experiments using lime and manure together, in various amounts.

**Artificial Fertilisers.**

The following fertilisers were tested :—ammonium sulphate, sodium nitrate, urea, potassium sulphate, superphosphate, and bone meal. The potassic and phosphatic fertilisers were thoroughly mixed with sterile soil before potting the plants. To avoid washing out of the nitrogenous manures the plants were potted in sterile soil and well watered. When the excess water had drained away the nitrogenous fertilisers were pricked into the wet soil. The plants were only lightly damped during the experiment. One week was allowed to elapse between potting and inoculation.

The results obtained are shown in Tables V. and VI.

**Table V.**

| Fertiliser. | Amount expressed as per cent. | No. of plants. | Degree of Attack. None. | Slight. | Fair. | Bad. | Very Bad. |
|---|---|---|---|---|---|---|---|
| Ammonium sulphate | 0.1 | 16 | 2 | 8 | 3 | 3 | — |
| ,, ,, | 0.25 | 18 | 2 | 8 | 3 | 3 | — |
| ,, ,, | 0.5 | 23 | 6 | 11 | 1 | 2 | 3 |
| Sodium nitrate | 0.1 | 6 | 1 | 2 | 1 | 2 | — |
| ,, ,, | 0.25 | 6 | 2 | 1 | — | 1 | 1 |
| ,, ,, | 0.5 | 6 | 3 | — | 1 | 1 | 1 |
| Urea | 0.1 | 6 | — | 1 | 1 | 2 | 2 |
| ,, | 0.25* | 6 | — | — | 1 | 1 | 2 |
| Potassium sulphate | 0.25 | 6 | — | 1 | — | 2 | 2 |
| ,, ,, | 0.5 | 8 | — | 1 | — | 3 | 3 |
| Superphosphate | 0.25 | 6 | — | — | — | 5 | 1 |
| ,, | 0.5 | 9 | — | — | — | 5 | 3 |
| Bone-meal | 0.25 | 4 | 1 | — | 1 | 2 | — |
| ,, | 0.5 | 8 | — | — | 2 | 5 | 1 |
| Control | Soil only | 23 | 1 | 2 | 7 | 2 | 9 |

* Two Scorched.

**Table VI.**

| Date of inoculation. | Date of observation. | No. of Plants. | Compost. | Degree of Attack. None. | Slight. | Fair. | Bad. | Very Bad. |
|---|---|---|---|---|---|---|---|---|
| 8/9/25 | 17/9/25 | 5 | Soil only ... ... ... | — | — | 1 | — | 4 |
| 8/9/25 | 17/9/25 | 5 | 0.5% Ammonium sulphate<br>0.5% superphospate ...<br>0.5% potassium sulphate | 1 | 3 | — | 1 | — |
| 8/9/25 | 17/9/25 | 5 | 0.5% Ammonium sulphate<br>0.5% superphospate ... | 1 | 3 | — | — | 1 |
| 8/9/25 | 17/9/25 | 5 | 0.5% Superphospate ...<br>0.5% potassium sulphate | — | 1 | — | — | 4 |
| 8/9/25 | 17/9/25 | 5 | 0.5% Ammonium sulphate<br>0.5% potassium sulphate | 1 | 3 | 1 | — | — |

It was evident from these results that potassium sulphate, superphosphate and bone meal, when used in the amounts shown in the tables, were of no use in controlling the disease.

The results shown in Tables V. and VI. suggested that the nitrogenous manures, with the exception of urea, were beneficial. Later experiments, however, yielded somewhat contradictory results and hence it is not possible to make any definite statement until further work has been done.

**Soil Sterilisation.**

Copiously infected soil, containing the sclerotia or resting bodies of the fungus, was used for these experiments. It was assumed that sclerotia are present in the soil under natural conditions; hence it was argued that if the tests were to be reliable the soil used must contain these bodies.

**Steam.**

Forty plants were tested in soil which had been steamed for two hours. In three weeks the plants were examined and in no case was there any infection. All the controls were badly diseased.

**Baking.**

Diseased soil was baked for one hour at 200° to 205° F. Plants potted in this soil remained perfectly healthy.

**Fungicides.**

Before treating any soil two representative control samples were taken. One sample was used for potting at once. The other sample was given the same amount of water as the amount of fungicide applied to a treated sample, and was used for potting at the same time as the treated sample. This control sample is the one mentioned in Table VII.

To ensure thorough mixing of the fungicides with the particles of the soil, the latter was put through a sieve with $\frac{1}{4}$" mesh and was turned over during the application.

The fungicides were applied by means of an ordinary watering can. Unless otherwise stated in the table, soil treated with volatile compounds was covered for 48 hours in order to retain the vapours. Table VII. summarises the treatments and the results obtained.

**Table VII.**

| Fungicide. | Application. | Lbs. of Soil. | No. of Plants. | Degree of Attack. None. | Slight. | Fair. | Bad |
|---|---|---|---|---|---|---|---|
| Formaldehyde ... | 300ccs. of 2.0% solution | 4 | 5 | 1 | — | — | 4 |
| ,, ... | 600ccs. of 2.0% solution | 4 | 5 | — | — | — | 5 |
| ,, ... | 400ccs. of 4.0% solution | 4 | 5 | 5 | — | — | — |
| ,, ... | Control 600ccs. water... | 4 | 5 | — | — | — | 5 |
| Cresylic Acid ... | 1.63ccs. in 400ccs. water (=1 gall. to 24 sq. yds.) | 4 | 6 | 1 | 3 | 2 | — |
| ,, ... | 3.26ccs. in 400ccs. water (=1 gall. to 12 sq. yds.) | 4 | 6 | 1 | 1 | — | 3 |
| ,, ... | 3.26ccs. in 130ccs. water | 4 | 6 | — | 3 | — | 3 |
| ,, ... | 3.26ccs. in 50ccs. water (absorbed on sand) ... | 4 | 6 | — | — | 1 | 5 |
| ,, ... | 6.52ccs. in 400ccs. water (=1 gall. to 6 sq. yds.) | 4 | 6 | 2 | 1 | — | 3 |
| ,, ... | 6.52ccs. in 260ccs. water | 4 | 6 | 2 | — | — | 4 |
| ,, ... | Control 400ccs. water... | 4 | 5 | — | 2 | — | 3 |
| Lysol ... ... | 1.63ccs. in 400ccs. water | 4 | 6 | — | — | 3 | 2 |
| ,, ... ... | 3.26ccs. in 400ccs. water | 4 | 6 | — | 1 | 2 | 3 |
| ,, ... ... | 3.26ccs. in 130ccs. water | 4 | 6 | 1 | — | — | 5 |
| ... ... | Control (see Cresylic Acid) | | | | | | |
| Cresofin* ... ... | 400ccs. of 0.25% solution | 4 | 6 | 1 | 1 | — | 3 |
| ,, ... ... | 400ccs. of 0.5% solution | 4 | 6 | 1 | — | 2 | 3 |
| ,, ... ... | 400ccs. of 1.0% solution | 4 | 6 | 1 | 3 | 1 | 1 |
| ,, ... ... | Control (see Cresylic Acid) | | | | | | |
| Phenol ... ... | 400ccs. of 0.18% solution | 4 | 5 | — | — | — | 5 |
| ,, ... ... | 400ccs. of 2.0% solution | 4 | 5 | 4 | — | — | — |
| ,, ... ... | 50ccs. of 0.72% solution | 4 | 5 | — | — | — | 5 |
| ,, ... ... | Control 400ccs. water... | 4 | 5 | — | — | — | 5 |
| Potassium dichlorcresylate† | 0.556ccs. in 400ccs. water | 16 | 18 | — | — | — | 18 |
| ,, ... | 1.112ccs. in 400ccs. water | 16 | 18 | — | — | — | 18 |
| ,, ... | 2.224ccs. in 400ccs. water | 16 | 18 | — | — | — | 18 |
| ,, ... | 2.224ccs. in 800ccs. water | 16 | 18 | — | — | — | 18 |
| ,, ... | 4.448ccs. in 800ccs. water | 16 | 18 | — | — | — | 18 |
| ,, ... | 4.448ccs. in 400ccs. water (=1 gall. to 9.5 sq. yds.) | 4 | 5 | 5 | — | — | — |
| ,, ... | Control 800ccs. water ... | 16 | 12 | — | — | — | 12 |

*Proprietary article.
† 0.8 pounds per litre.

**Table VII.** *(continued.)*

| Fungicide. | Application. | Lbs. of Soil. | No. of Plants. | Degree of Attack. None. | Slight. | Fair. | Bad. |
|---|---|---|---|---|---|---|---|
| Potassium dichlorphenate† | 0.815ccs. in 400ccs. water | 4 | 5 | — | 1 | — | 4 |
| ,, ... | 1.63ccs. in 400ccs. water | 4 | 5 | 1 | — | — | 4 |
| ,, ... | 3.26ccs. in 400ccs. water | 4 | 5 | 3 | 1 | 1 | — |
| ,, ... | Control 400ccs. water ... | 4 | 5 | — | — | — | 5 |
| Copper sulphate ... | 800ccs. of 3.0% solution (soil washed after 18hrs.) | 4 | 5 | — | — | — | 5 |
| ,, ... | 800ccs. of 3.0% solution (soil not washed) ... | 4 | 6 | — | 2 | 2 | 2 |
| ,. ... | Control 800ccs. water (soil washed after 18hrs.) | 4 | 5 | — | — | — | 5 |
| Bleaching powder . | 800ccs. of 3.0% suspension in water (soil washed after 18hrs.) ... ... | 4 | 5 | — | — | — | 5 |
| ,, ... | 24.0 grams mixed with soil (left several weeks) | 4 | 6 | 3 | 1 | — | 2 |
| ,, ... | Control (see Copper sulph.) | | | | | | |
| Milton* ... ... | 400ccs. of 10.0% solution (soil washed after 18hrs.) | 4 | 5 | — | — | — | 5 |
| ,, ... ... | Control (see Copper sulph.) | | | | | | |
| Potassium permanganate ... | 500ccs. of 1.0% solution | 4 | 5 | — | — | — | 5 |
| ,, ... | Control 500ccs. water ... | 4 | 5 | — | — | 1 | 4 |
| Flowers of sulphur | 0.5% mixed with soil (left three weeks) ... ... | 4 | 6 | 1 | — | 1 | 4 |
| ,, | Control ... ... ... | 4 | 6 | — | 1 | 2 | 3 |
| Ammonium carbonate ... | 400ccs. of 0.25% solution | 4 | 6 | — | — | 1 | 5 |
| ,, ... | 400ccs. of 1.0% solution | 4 | 6 | — | 1 | — | 5 |
| ,, ... | 400ccs. of 4.0% solution | 4 | 6 | 4 | 2 | — | — |
| ,, ... | 400ccs. of 5.0% solution | 4 | 5 | 3 | 2 | — | — |
| ,, ... | Control 500ccs. water ... | 4 | 5 | — | — | 1 | 4 |
| Ammonium hydroxide ... | 400ccs. of 5.0% solution | 4 | 5 | 3 | 2 | — | — |
| ,, ... | Control (see Ammonium carbonate) | | | | | | |

* Proprietary article.
† 0.8 pounds per litre.

The above table shows that heavy applications of formaldehyde, phenol, potassium dichlorcresylate, potassium dichlorphenate, ammonium carbonate and ammonium hydroxide, checked the disease.

The remaining fungicides tested had little or no effect under the conditions of the experiments.

An attempt is being made to determine whether the above heavy applications can be reduced and yet remain effective.

**Dusting Experiments.**

By means of a " dibber " twelve holes were made in infected soil. The inside of six holes was coated with a mixture containing three parts copper sulphate, three parts flowers of sulphur and ten parts air slaked lime. The remaining six holes served as controls.

Plants with clean soil attached to their roots were then transferred to the holes, the procedure being similar to actual practice when planting out in the glasshouses. The surface soil immediately surrounding the plants placed in the treated holes was then dusted with the mixture. After four weeks the plants were examined and all twelve plants were badly attacked, there being no difference between those treated and the controls.

**Cross Inoculations.**

The following plants were successfully infected :—Tobacco, Aster, Pentstemon, Lobelia, Sweet-pea, Snapdragon, Viola, Cosmos, Lettuce, Cauliflower, Celery, Potato (plants), Carrot (fleshy root), Cucumber, White Deadnettle, Sun-spurge and Black-nightshade.

The fungus has a wide range of hosts which may serve to maintain its virulence in the absence of tomato plants ; hence the necessity for destroying weeds in and about the glasshouses.

**Summary.**

1. A " foot-rot " disease of tomato plants from Guernsey, caused by *Rhizoctonia solani*, has been described and investigated.
2. The fungus lives in the soil where it forms resistant resting bodies called sclerotia. It has a wide range of hosts.
3. Eight varieties of tomato have been tested and all were equally susceptible.
4. Complete control was obtained by steaming or baking the soil.
5. Several fungicides have been tested but only heavy applications of certain compounds were effective in controlling the disease.
6. A warm, dry soil checked the spread of the disease.
7. Atmospheric temperatures from 58.7° F. to 67.3° F. resulted in heavy infection. Above 72° F., providing the soil was fairly dry, the severity of the attack diminished. Above 80° F. little infection resulted even when the soil was very moist.

8. Slaked lime, potassic and phosphatic fertiliser had no beneficial effect. Sterilised stable manure, applied at the rate of 30 tons per acre, aggravated the disease.

**Control Methods.**

At the present stage of the investigation the following methods of control are suggested.

Steaming or baking the soil will completely eradicate the disease. When preparing the soil in spring it must be borne in mind that warm, dry, well aerated conditions retard the progress of the disease. Good ventilation and hoeing the soil around the plants will help to dry the surface soil. The houses should not be shaded as this lowers the temperature and conserves the soil moisture. Ridge planting is to be preferred to furrow planting. Weeds, in and about the houses should be destroyed.

## A Disease of the Strawberry Plant.

T. Small.

Diseased Strawberry plants grown under glass, were submitted for examination during October. The roots of these plants were black and the rotted cortex was easily removed from the healthy central cylinder. The crowns were apparently healthy but the majority of the leaves were dead.

Microscopic examination showed that, in addition to numerous eelworms, fungal hyphæ were present in the cortical cells of the roots and in the soft tissues of the leaf petioles.

Six different fungi were isolated and tested for pathogenicity. One proved to be pathogenic and inoculation of either leaf petioles or crowns of healthy strawberry plants were always successful. The fungus was re-isolated from the lesions produced and would therefore appear to be the organism responsible for the disease in question.

The fungus has not been fully identified, but Miss Wakefield, who has kindly examined a culture, considers it to be probably a *Diplodina*, and suggests that it may prove to be a strain of *D. lycopersici.*

The fungus grows upon most of the ordinary nutrient media, and is characterised by the production of a "dark plate" and scattered pycnidia containing numerous conidia which occasionally become one-septate.

Stem inoculations into tomato, tobacco and cucumber plants have resulted in collapse of the tissues, reminiscent of the effect of the old tomato "canker," *Diplodina lycopersici.*

Further investigations are in progress.

# Mosaic Disease of the Cucumber.

W. F. Bewley.

**1. Control by the use of clean seed.**

Observations of Mosaic disease in cucumber houses, undertaken during the past five years, provided sufficient evidence to justify an investigation of the possible transmission of this disease by means of the seed.

The obvious method of saving seed from infected plants has not provided convincing evidence of seed transmission because out of 2,000 seeds taken from diseased individuals, only nine produced plants which developed mosaic disease in the pot stage.

Another method which utilises information from many thousands of plants is that of following up the history of different batches of seed which have been saved and grown by nurserymen. By this means strong circumstantial evidence of seed transmission has been obtained. It has been found on several nurseries in the case of plants from seed sown at the same time and cultivated under similar conditions that those from one batch of seed may be healthy while those from other batches are infected with mosaic disease. See the following table :—

**Table I.**

The presence of mosaic disease in plants raised from different batches of seed.

| Nursery. | Year in which seed was sown. | Year in which seed was saved. | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1916. | 1920. | 1921. | 1922. | 1923. | 1924. |
| 1 | 1923 | H | — | — | M | — | — |
| 2 | 1924 | — | — | M | M | H | — |
| 3 | 1924 | — | — | H | M | M | — |
| 4 | 1924 | — | — | M | H | H | — |
| 5 | 1925 | — | — | M | M | H | H |
| 6 | 1925 | — | — | H | H | M | M |

H=Healthy crop.
M=Mosaic disease present and causing loss.

Further, seedlings raised in steam sterilised soil, contained in sterilised pots and growing in specially cleansed houses have shown signs of mosaic disease four weeks after sowing.

It seems reasonable to conclude that seeds taken from fruits borne by mosaic infected plants do not invariably produce infected progeny, neither do they invariably produce healthy progeny, for a small percentage of infected seedlings occur from time to time.

In view of this evidence an attempt was made to obtain cucumber seed which was free from mosaic virus. In 1922 Mr. H. O. Larsen very kindly supplied some seeds of Butcher's Disease Resister which had been stored in a sealed tin since 1916. The seeds were sown in December, 1922, and grown in the experimental houses of the station during 1923. One thousand plants were grown and all were apparently free from mosaic disease. Seed was saved from selected plants and stored for further use. In 1924, seed was obtained from a different source. Mosaic disease appeared while the plants were in size 60 pots, and although infected plants were destroyed at sight, the disease reappeared after the plants had been planted in the beds, and it spread until every plant became infected.

In July, 1924, some of the seed saved from the healthy crop of 1923 was supplied to a grower whose cucumber crop had been attacked by mosaic disease during five years previously, and where all attempts to control it had failed. He sowed the clean seed during July, 1924, at a tomato nursery remote from any cucumber plants, and raised sufficient seed for the other nursery where mosaic disease was prevalent. In 1925 the seed was used at the latter nursery and the plants in five acres of glasshouses were free from mosaic disease until June, 1925, when it was observed in three small houses. These houses were isolated and the disease prevented from spreading. At the end of the season these houses were still diseased, but the others remained clean, and the total crop was 33% higher than in any of the previous five years. The appearance of mosaic in the three houses may appear disquieting, but in view of the evidence supplied in the second portion of this report they might be explained by soil infection.

While admitting that further trials are necessary before claiming that the use of mosaic-free seed offers a real control of this disease, the present results warrant extended trials being made. The strain under examination is not immune to mosaic disease, because it can be easily infected by ordinary methods of inoculation.

**II. Can mosaic disease of the cucumber be contracted from the soil?**

That mosaic disease of the cucumber can be contracted from beds which have previously borne a diseased crop is a common belief among nurserymen, and as such it cannot be neglected without critical examination. Opportunity for such critical experiment has not yet appeared, but the experience gained from the station experiments during 1925 lend support to the belief in soil infection.

During this year the plants were raised from the mosaic free seed saved in 1923. Mosaic was entirely absent until May 7th, 1925, when it appeared suddenly in two beds, 17 plants out of

36 being infected. As these plants were carefully examined every third day, it is very unlikely that the disease appeared earlier in one plant and then spread to the others. Although reasonable care was taken to prevent it, the disease spread slowly until the end of July, when every plant in the block of three houses showed typical symptoms. In two other isolated houses containing plants which were raised under identical conditions from the same batch of seed, no Mosaic disease ever appeared. The accompanying diagram, Fig. 1, shows the position of the original infection and the method of spreading.

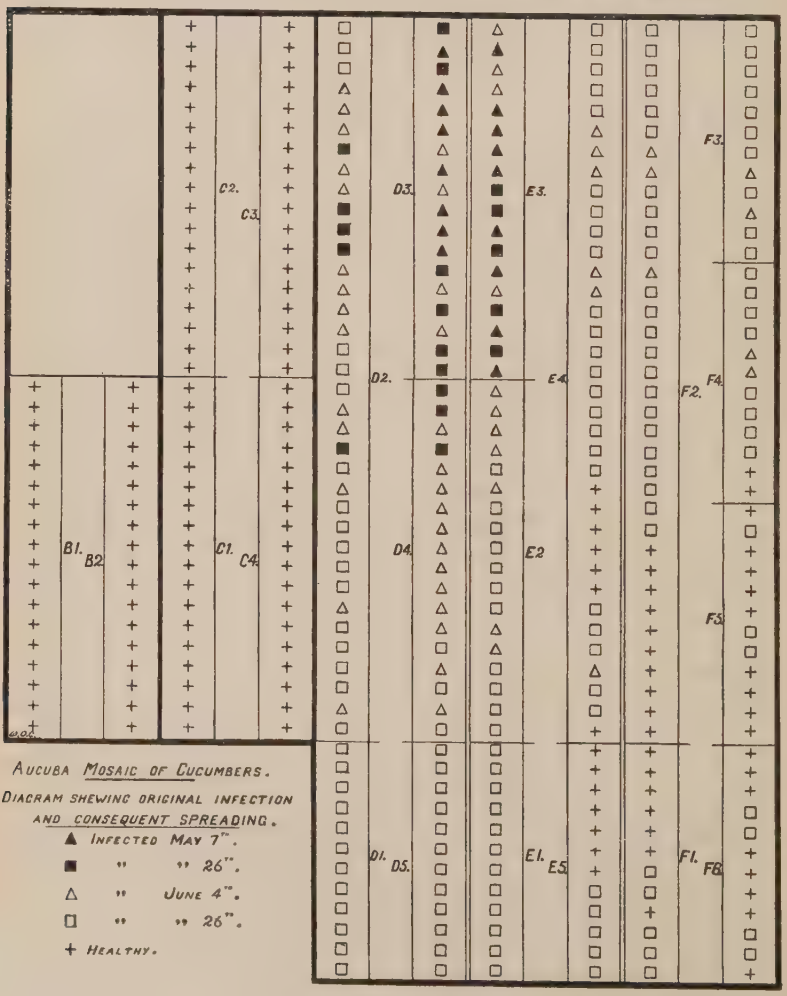


Fig. 1.

It will be seen that the original infection occurred on plots D3 and E3, the history of which is instructive.

For the purpose of another experiment, plots D3, D4, E2 and E3 consisted of a compost of two parts loam and one part stable manure placed on a slightly convex concrete base. The compost above the concrete was introduced for the 1924 crop, and this supported a crop of cucumbers during that year. In January, 1925, beds D4 and E2 were spread over the concrete and steamed *in situ*. Beds D3 and E3 were also spread over the concrete but were left unsteamed. The beds in all other plots in the experimental block, except F3, 4, 5 and 6 were removed during October, 1924, to a large heap outside the houses. The beds in F3 and F4 were spread over the soil, while those in F5 and F6 were spread and steamed. It will thus be seen that the history of D3 and E3 correspond to F3 and F4, while those of D4 and E2 correspond to F5 and F6, except in the matter of the base. D3, D4, E2 and E3 were placed over a concrete base, while F3 to F6 rested on the soil. Thus D3 and E3 were in worse condition at the end of the season than F3 and F4. The crop in 1924 was badly infected with mosaic disease, which in 1925 appeared suddenly in large amount in D3 and E2 and did not appear in F3 and F4 until transmitted by mechanical agencies.

The sudden appearance of mosaic disease in the old beds, coupled with the fact that the crop in the self-contained houses B and C remained healthy throughout the season, points towards soil infection. Critical experiments have been arranged for 1926.

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# Entomological Investigations.

## **Red Spider** *(Tetranychus telarius*, L.*)*.

### Life History and Seasonal History.

Reference has been made in previous reports to the habits of the Red Spider in glasshouses and the inquiry has now reached a stage where a general description of the life-history is called for. Material at hand for this description, covers most detail which is likely to be useful in devising control measures, but much light has still to be thrown upon the origin of severe invasions of this mite at certain periods of the growing season.

The principal plants frequented by spider in glasshouses are cucumber, tomato, grape-vine, carnation, asparagus-fern and beans, less often arum and rose. Injury to the foliage of these

plants is principally, if not entirely, caused from feeding by the adult female during the period of oviposition, with secondary mechanical effects due to spinning of extensive webs over the plants attacked. In the young stages the mites do not appear to cause damage of any kind.

Winter is passed in the adult stage, the spider, previous to hibernation, assuming a brilliant red colour ; the majority of hibernating adults are females and have been impregnated before the appearance of the red pigment, which is also shown in the few males which hibernate.

Hibernating adults are gregarious, and these collect, often in vast numbers, in crevices inside and outside glasshouses, especially under the ridge-capping and under metal fittings securing the ventilators to the ridge : in tomato houses hollow canes and straw mulch are favourite situations, preference being shown for pieces of the latter bearing an ear. The spider spin a small amount of webbing in their winter quarters, seldom become entirely dormant, and can withstand severe frosts. Excess of moisture is fatal to them.

Under favourable temperature conditions, the red forms may remain on the foliage of plants grown through the winter, notably upon carnation, but they are inactive and have not been observed to lay eggs ; side by side with them are forms which do not assume the red colour, and continue to breed slowly, at least for the majority of the winter months. Hibernation is at an end with some, but by no means all, individuals when cucumber and tomato seedlings are potted up in the propagating house. In January or February red females are found sparingly on the lower leaves of these plants, and begin to lay eggs, the development of which is slow, and the adults of the first annual generation mostly assume the red colour characteristic of the hibernating form, leave the plants, and enter another resting period. The few individuals which do not turn red breed sparingly till the middle of March, when the adults of the second generation behave similarly to those of the first.

After the plants have been placed in the ground but not till the middle or end of March, another invasion of hibernating adults takes place, this marking the starting point of the summer generations, and it is possible though not entirely probable, that all the hibernating forms leave their winter quarters at this time. The *Eggs* are laid on the underside of the leaves, each lying behind the puncture made by the mouth parts of the female, and are minute spherical white objects, usually attached to webbing spun by the mother. They tend to become yellowish as hatching approaches. The resulting *Larva* is pale yellow and has three

pairs of legs : it is sluggish and soon enters a resting period in which it is rigid and devoid of all movement. The skin splits and the *Protonymph*, sometimes exceedingly active, with four pairs of legs, is disclosed. The sexes are now differentiated, the male becoming elongate, and remaining longer in this stage than the female. A second resting stage is entered, and a second moult discloses the *Deutonymph* in the case of the female and the *Adult* in the case of the male sex. The female *Deutonymph*, like the previous stages, passes through an active and a resting period, and on moulting becomes the *Adult* female. The small elongated and active males keep to the vicinity of the resting female deutonymphs, and copulation takes place immediately after emergence of the females.

At the temperatures prevailing in cucumber houses, the various stages of development occupy the following periods :—

| Stage. | | Male. | Female. |
|---|---|---|---|
| Egg ... ... ... ... ... | | 4-7 days | |
| Larva ... | Active period ... | 1 day | |
| | Resting period ... | 1 day | |
| Protonymph... | Active period ... | 1½ days | 1 day |
| | Resting period ... | 1½ days | 1 day |
| Deutonymph | Active period ... | | 1 day |
| | Resting period ... | | 1 day |
| | | 9-12 days | 10-13 days |

After impregnation, the females do not begin laying eggs for at least 12 hours, but if no males are present, eggs are laid very soon after the last moult, and these develop to males only. Fertile eggs usually produce about 80% females and 20% males. Females lay eggs to the number of about 90 over a period of some three weeks, so that in summer two generations may be produced during the life of a single individual. Only adult spider appear to spin webs, and the summer females are of a yellowish colour at first, usually with some dark markings dorsally ; later the black pigment extends as oviposition proceeds, until the whole animal appears of a deep black colour. Breeding is continuous after the end of April through the summer, and the number of generations produced is not less than two a month in cucumber houses, until the middle of August.

The spider now make ready for hibernation, but at the same time an invasion seems to take place from other sources than from the spider present at the time upon the foliage in the houses. There is a tendency for all stages of the spider in late August to assume a reddish colour, and this is preliminary to the weaving

of very extensive webs, and the formation of "ropes," often more than two feet in length, in which many hundreds of spider become suspended apparently on a single thread. These ropes usually hang from the tip of a leaf, and at the free end, but sometimes in the middle or at the point of attachment, some 50-100 spider spin themselves into a cocoon, the fate of which is at present unknown. The other individuals comprising the majority, disperse, running actively over foliage, and on the ground, and eventually congregate in places suitable for hibernation.

In tomato houses, where conditions are different, these ropes and cocoons do not appear to be made at all, and the preparation for hibernation lasts over a much longer period, until the middle or end of September.

There appear to be a few individuals which do not prepare for hibernation, and, if food is available, go on breedling slowly until the plants are removed.

The spider which form ropes are not all adults, and quite young stages have been found in the cocoons, but no young stages occur among those which have congregated for hibernation after leaving the plants. It is improbable that red spider hibernates in the ground, as dry places are selected for the winter, and plants potted in soil from heavily-infested houses, and kept over the winter, have shown no signs of infestation. The production of red forms is coincident with lack of food and fall in temperature. There appear to be marked differences in the seasonal activity of spider on different types of plant, and it is concluded that there are definite races of the animal which are adapted to living only on certain plants. Further, red spider appears to be adapted to breeding upon certain plants at certain times of year; thus the time of maximum infestation upon carnation plants does not coincide with that in cucumber or tomato houses, and plants such as Banana and Salvia upon which spider will readily collect for hibernation, are free of the pest by the beginning of June.

The suspected presence of these races might explain the very noticeable and serious increase of the pest upon tomato plants in recent years; a race breeding upon some weed outside the houses might be adapted naturally to feeding upon tomato foliage, and having once gained access to the houses, would quickly establish itself there. It is probable that there is some succession of choice of food-plant, which would explain the well-known fact that tomato plants grown under heavily-infested cucumber plants in mid-season, seldom if ever take the infection directly from the latter, though spider taken during hibernation from tomato houses will breed readily upon cucumber foliage.

It has long been known that certain varieties of Tomato are less susceptible to attack than others. On one nursery where the attack was very severe last year, the Comet variety was planted this year, and the plants became infested to any considerable extent only late in the season. The experimental variety plots in August showed a minimum infestation on Comet x Manx Marvel cross, with slight infestation on Comet and Radio. Moderate attack occurred upon Pale Blako, Ailsa Craig, and the latter crossed with Manx Marvel, while Clarke's Masterpiece, Best of All and Tuckswood were severely attacked.

The manurial plots showed little or no evidence of response to treatment in connection with prevalence of spider, but individual plants throughout the houses, and especially in the new block, showed a marked resistance. These plants were of a uniform type, vigorous and sappy, with large leaves and dark stems. On nurseries whole blocks of houses of this type have been observed irrespective of variety, and they have been entirely or practically free of spider.

Two natural enemies of Red Spider have been observed—one a mite occurring rarely on Cucumber foliage, and the other the larva of a Cecidomyid fly, *Therodiplosis persicae*, K., in tomato houses. The latter became very prevalent in September, at a time too late to exert any control over the pest. The larva of this fly is of a red colour and spins a white cocoon on the under surface of the leaf, in which to pupate. The fly resembles a midge with long legs and lays elongate eggs in the webs spun by the spider.

**Fumigation of Cucumber Plants with Naphthalene.**

The broadcasting of pure commercial white-flake naphthalene, after passing through a sieve of 16 meshes to the inch, now known as "grade 16 naphthalene," has been followed during the past season by many growers of cucumbers, and in general principle there is little to add to the instructions first circulated, except to emphasise the absolute necessity for keeping the foliage and atmosphere moist during the whole time of fumigation. There has been serious scorching where this detail has been neglected.

Experiments have been carried out in which either flake or powdered naphthalene has been dusted upon foliage of growing plants, kept under moist and dry conditions, and almost invariably there has been damage in the latter case, and never in the former.

Dusting is not to be recommended as a control measure for red spider, as the volatility of naphthalene under these conditions may be so high that the vapours disappear before the spider have been killed.

**1. Effect of Naphthalene Vapour on Young Plants.**

In January the effect of naphthalene vapours upon seedling plants in " 60 " pots was studied. In a house of 1,000 cubic feet capacity, 1 lb. Grade 16 naphthalene was distributed over the staging at 10.0 a.m., some plants being watered, others not. The temperature rose to 80°F. at 2.0 p.m., and at 2.30 p.m. the growing points of all the plants began to bend over. The foliage remaining turgid. At 5.0 p.m. some of the plants were removed and recovered quickly. Those left in the house until the vapours had disappeared (36 hours) also recovered, but those which had received no water took longer to become normal than those watered at the beginning of or during the experiment.

Using older pot-plants, 2 lbs. naphthalene were thrown over the staging of the same house at 6 p.m. During the night, the temperature fell to 58°F. and much naphthalene condensed on the glass of the house. The following morning the lower leaves and cotyledons were slightly scorched at the leaf tips and edges. During the day the temperature rose to 70°F. and there was no further scorching, all the plants being watered. Spider on other plants in both these experiments were not killed.

A third experiment was conducted similarly using 3¼ lbs. naphthalene distributed beneath the staging, the atmosphere being kept very moist. Temperatures ranged from 64°F. to 80°F., and there was no damage of any description ; a fair mortality of spider was recorded.

These experiments show that young cucumber plants react to naphthalene vapours, and that there may be damage to foliage if the atmosphere is dry, and if such a condition is accompanied by a fall in temperature sufficient to cause condensation of vapours.

**2. Effect of Naphthalene upon the Root.**

A question has been raised as to the possibility of naphthalene, when broadcast on cucumber borders, reaching the roots of the plants, and thereby causing injury.

The volatile nature of naphthalene, its rapid disappearance when mixed with soil, and the fact that the flakes are insoluble in and float upon water, make this highly improbable. However, in June an ordinary fumigation was made, and the roots of several plants were partially exposed so that naphthalene actually came into contact with them. None of the plants in the house showed the slightest injury.

**3. Effect of the Vapour upon Flowers and Fruit.**

During a fumigation of the main block of cucumber houses at the Experimental Station in May, male and female flowers and a number of developing fruit were marked and their subsequent

development observed. Temperatures ranged from 72°F. to 96°F. during fumigation. Flowers of both sexes were unaffected by the vapours, and of 14 fruit in early stages of development, 12 were cut ten days after the fumigation and had an average weight of a little over 1 lb. each ; the other two did not develop.

This suffices to show that naphthalene fumigation is not the primary cause of non-development of fruit, and of fruit becoming " crooked " or deformed. The latter trouble is undoubtedly due to influence of climate, and usually occurs when a period of rapid growth is followed by a cool spell with little sun.

Flowers appear to be less affected by the vapours than the foliage, for in a fumigation where leaves were severely scorched through insufficient watering, flowers remained unharmed.

On the other hand, a case was recorded early in the season where plants had been forced on rapidly, and a surplus of bloom had been allowed to set ; some of the houses were fumigated under these conditions, and though there was no injury to foliage, the bloom died off more rapidly in the treated houses than in those untreated.

Here, the flowers were in an unhealthy condition, and it is natural that fumigation should have accelerated their death. It is therefore not improbable that a fumigation might tend to increase non-development or malformation of fruit, if conditions of climate favoured such conditions, but under normal circumstances the effects of fumigation cannot be great.

**4. Prolonged Action of Vapours upon the Plant.**

To find out if the rate of increase of red spider could be checked by keeping a constant odour of naphthalene in a cucumber house, $1\frac{1}{4}$ ozs. naphthalene were placed round each collar of 36 plants on April 27th, the spider infestation being small at the time. On May 5th, the naphthalene had almost disappeared, temperatures having varied between 71°F. and 94°F. The treatment was repeated but after two days the collars showed signs of injury, and the foliage took on an unhealthy yellowish colour. Meantime, the spider had increased notably. On removal of the naphthalene, and drying of the collars with lime, the plants gradually became normal. During the experiment the odour of naphthalene was at times fairly strong, but the spider increased normally, and though treatment of the plant collars in this case was drastic, the effects of long exposure to naphthalene cannot be recommended.

**5. Hardening of Foliage from the Vapour.**

There is no evidence that fumigation carried out normally has the effect of hardening the plant so that production of new growth is retarded. Plants which have been severely scorched by the vapours under abnormal conditions put out new shoots with great rapidity, and the foliage is soft and vigorous.

**6. Effects of Temperature and Humidity.**

Fumigation by broadcasting naphthalene is not likely to be successful if temperatures above 74°F. are not maintained during the whole period of fumigation.

Using the normal 6 lbs. naphthalene to 100 foot house, two experiments were made in which the night temperature fell to 61°F. and 68°F. respectively, the maximum day temperature being 92°F. In both cases large numbers of spider were killed, but numbers of eggs hatched and a low mortality amongst the resting stages was recorded.

In one case, where the plants were kept rather dry, weak leaves were slightly scorched during the night, and later the foliage assumed a yellowish colour.

Towards the end of July reports were received that the effects of fumigation did not appear so good as earlier in the season, and it was ascertained that heating of the houses at night had been stopped.

A house, the atmosphere of which was difficult to keep moist, was given a heavy dose of naphthalene on a hot morning in May. Until 3.30 p.m. the plants were continually damped over, but then allowed to become dry ; already at 4.0 p.m. the foliage showed considerable scorching, which was arrested immediately by further damping.

**7. Variation in Dose and Time of Application.**

Experiments were carried out using 3 lbs. and 4½ lbs. Grade 16 naphthalene to the 100-foot house, as against the normal 6 lbs.

To obtain fair distribution, the amounts given were made up to 6 lbs. with artificial top-dressing fertiliser or with fine sand. In no case did the use of a less quantity than 6 lbs. give satisfactory results, and it appeared that only small amounts of vapour came off from the top-dressing mixtures.

A double quantity (12 lbs. to 100 ft. house) of grade 16 naphthalene was distributed on the borders and paths of a badly infested cucumber house at 5.0 p.m. on July 1st at a temperature of 93°F. The minimum temperature at night was 74°F. The following day, the temperature rose to 106°F. and was at once reduced to the region of 100°F. by slightly opening the ventilators, which were closed again at 5.0 p.m.

There was no injury whatever to the plants and the spider were killed ; on July 7th, some eggs on leaves immediately below the ventilators hatched, and the young from these reached the deutonymph stage on July 9th. On July 10th another 12 lbs. naphthalene was broadcast at a temperature of 95°F. and after this no living spider could be found in the house. On July 22nd a single adult male and a female deutonymph resting stage, both alive, were found on one leaf near the door of the house, and it is possible that these had gained access from outside, in an earlier stage of development. A similar experiment, using 18 lbs. naphthalene to 100-foot house, gave the same results ; though in this case the ventilators were not opened at all during the day, some eggs hatched on the 7th day after fumigation, and another 18 lbs. naphthalene were broadcast. Eighteen days after the first, and 11 days after the second fumigation, no living spider could be found in the house. On the 24th day, however, two living adult females were found; these had laid no eggs, and had evidently gained access from outside.

These records show that a greatly increased dosage neither affects the plants, nor necessarily serves to produce greater mortality amongst the spider. According to atmospheric temperature, only a certain quantity of naphthalene vapour can be held in the air, and within the limits of a favourable cucumber-house temperature, the action of the vapour upon red spider does not appear to vary much.

In several experiments—some on a large scale—fumigation was started in the morning instead of late afternoon. In some cases the results were favourable, but when day temperatures were very high, there did not appear to be enough naphthalene left after the first twelve hours to ensure complete destruction of the spiders—apart from the eggs. It is, however, important to have a high initial concentration of vapour at the beginning of fumigation, and this is best obtained by broadcasting the naphthalene at any time between 4 p.m. and 6 p.m. Fall of temperature at night must produce some condensation of naphthalene, and this may be of great advantage, provided that 74°F. is maintained.

**8. Fumigation in separate houses of a block.**

In a block of three houses, each 100 feet long, one house only was treated with 12 lbs. naphthalene, broadcast on borders and paths. Temperatures ranged between 74°F. and 100°F. 24 hours after application, the spider in the treated house, and the one adjoining it were motionless, while in the third house there was little effect. After the vapours had disappeared, some eggs hatched in the treated house, but otherwise the spider were killed. In the second house, on the border adjoining the house treated,

there was considerable mortality, but further away the spider recovered. A control of spider can, under favourable conditions, be obtained in a single house of a block by making two applications of naphthalene upon borders and paths, using 12 lbs. naphthalene to 100 ft. house at each fumigation, 6 to 10 days elapsing between the fumigations.

**9. Effect of Vapour upon the Eggs of Red Spider.**

It is clear that a great number of eggs are killed by a normal naphthalene fumigation. The dates of hatching of these which survive indicate that the latter are laid either shortly before or during fumigation. A female spider often lays two or three eggs quickly when exposed to naphthalene vapours, and it was thought that these might be unaffected by fumigation.

The following experiment was carried out as an attempt to throw further light upon this subject.

At 6.0 p.m. on July 20th, a block of three 100-ft. cucumber houses were fumigated, using 6 lbs. naphthalene, grade 16, on the borders of each house, the initial temperature being 98°F. Owing to very high temperatures during the following day, the ventilators were slightly opened ; 40 hours after the naphthalene was broadcast it had all volatilised.

Previous to fumigation, spider-free pot-plants had been infected with female spider, some fertile and some unfertile, which were removed to other uninfected plants from time to time and allowed to lay eggs for varying periods, so that eggs of all ages up to 4 days were present when the plants were placed in the houses immediately before fumigation. The original females together with many others were placed upon fresh plants.

After fumigation, the leaves of one series of plants were removed and kept in closed boxes, while the other series were kept in spider-free cages, control plants with eggs laid over the same period being treated similarly. All the leaves and plants were kept under close observation for a period of 9 days after fumigation.

When first examined, 40 hours after the beginning of fumigation, it was noted that the eggs were of different colours, some being reddish and others of the normal white colour. Counts made at this time gave the following figures for the fertile eggs :—

| Age of Eggs prior to Fumigation. | Red Eggs. | White Eggs. | Total. |
|---|---|---|---|
| 2½-4 days ... ... ... ... | 99 | 0 | 99 |
| 1½-2½ days ... ... ... ... | 27 | 5 | 32 |
| 1 hour-1½ days ... ... ... | 2 | 18 | 20 |
| | 128 | 23 | 151 |

Eggs laid shortly before fumigation had therefore preserved their normal colour to a greater extent than those more developed. Two days after, by which time more eggs had been marked on the detached leaves, the total count for both fertile and unfertile eggs was as follows :—

| Age of Eggs prior to Fumigation. | Fertile Eggs. Red. | White. | Total. | Unfertile Eggs. Red. | White. | Total. |
|---|---|---|---|---|---|---|
| 2½-4 days ... ... ... | 154 | 0 | 154 | 4 | 0 | 4 |
| 1½-2½ days ... ... ... | 63 | 1 | 64 | 37 | 5 | 42 |
| 1 hour-1½ days ... ... | 74 | 46 | 120 | 12 | 11 | 23 |
| | 291 | 47 | 338 | 53 | 16 | 69 |

By this time, the proportion of red eggs had increased very considerably, and when a final examination of all the eggs fumigated was made 9 days after, but few white eggs remained :—

| Age of Eggs prior to Fumigation. | Fertile Eggs. Red. | White. | Total. | Unfertile Eggs. Red. | White. | Total. |
|---|---|---|---|---|---|---|
| 2½-4 days ... ... ... | 191 | 0 | 191 | 4 | 0 | 4 |
| 1½-2½ days ... ... ... | 101 | 1 | 102 | 40 | 2 | 42 |
| 1 hour-1½ days ... ... | 212 | 65 | 277 | 45 | 11 | 56 |
| During fumigation ... | 0 | 2 | 2 | 5 | 0 | 5 |
| | 504 | 68 | 572 | 94 | 13 | 107 |

The total number of fertile females employed was 99 and of unfertile 11. Care was taken to select old as well as young adult spider, and for the parthenogenetic eggs, female deutonymph resting stages were isolated before emergence.

Of the 679 eggs, not a single one hatched, and it is unfortunate that so few were laid during the fumigation.

The white eggs were kept under observation for some time after the final count was made, and many retained their colour, but none hatched.

In the controls, 60 eggs laid by fertile and 63 by unfertile females hatched as follows :—

| Period after Laying. | Fertile Eggs. Hatched. | Unhatched. | Unfertile Eggs. Hatched. | Unhatched. |
|---|---|---|---|---|
| 5 days ... ... | 37 | 23 | 15 | 48 |
| 6 days ... ... | 41 | 19 | 61 | 2 |
| 7 days ... ... | 45 | 15 | 61 | 2 |

No more eggs hatched after this, and it is remarkable that a greater proportion of successful development was obtained from the unfertile eggs. The latter all developed to males subsequently

while the fertile eggs produced about 80% females. After the experiment, close watch was kept on the eggs laid naturally on the foliage of plants in the borders of the fumigated houses. None were observed to hatch, but on the 15th day after fumigation, an adult male and a male protonymph resting stage, both alive, were found on a single leaf, and this makes it probable, if these had not gained access from outside, that an insignificant number of eggs, laid either during the fumigation, or contained in the bodies of dead females, survived the vapours, and developed subsequently.

**10. Standardisation of Naphthalene.**

Grade 16 naphthalene, unless submitted to a special screening process, invariably contains a certain percentage of powder, which is undesirable, for in storage this powder tends to form hard lumps and when used for fumigating purposes, is liable to give uncertain results.

A sack of grade 16 naphthalene kept for 6 months contained over 40% powder passing a 36 mesh sieve. The two portions were tested against each other, using 6 lbs. of each, to a cucumber house 100 ft. long. The powder had nearly all volatilised 22 hours after broadcasting ; at this time the vapour in the house treated with the flake portion was at its height. The spider were not killed in the house treated with powder. From this and other fumigations carried out as tests, it is concluded that the best results have been obtained with powder-free flake naphthalene. A specially-screened 16-grade naphthalene has now been kept for over three months in an open sack, and such lumps as have formed break immediately on handling to the original flake.

The extra screening involves labour, and manufacturers are giving their aid in the production of an imitation grade 16 which contains little if any powder. Samples have been received and will be tested as early as possible next season.

**11. Summary of Results in the past Season.**

(I.) There is little to add or alter in the original instructions circulated to growers last year for the fumigation of cucumber-houses with grade 16 naphthalene for the control of red spider.

(II.) A sufficient control of this pest is maintained by single fumigations at intervals of about one month, if necessary, but to kill all spider two fumigations, the second not less than six and not more than 10 days after the first, should be carried out.

(III.) Scorching of the foliage is due to lack of moisture on the foliage and in the atmosphere during fumigation ; yellowing of the foliage is probably due to lack of moisture at the root of the plant or bad root action through disease, during fumigation. The danger of naphthalene obtaining access to the roots of plants in the border in sufficient quantity to do damage is negligible.

Malformation and abortion of fruit are due to climatic conditions, and are not primarily caused by naphthalene fumigation. Vapours of naphthalene may, however, aggravate these troubles to a slight extent.

(IV.) A single house of a block may be fumigated under favourable temperature conditions, in cases of isolated attack, by broadcasting an extra quantity of naphthalene, equal to that placed on the borders, upon the path of the house. There is no danger, and there may be some advantage in using a larger quantity than 6 lbs. to 100 ft. house, and the latter is the minimum effective dose.

(V.) The presence of large quantities of fine powder in grade 16 naphthalene is liable to decrease the efficiency of fumigation. Standardisation of naphthalene is therefore desirable.

(VI.) The keeping of a persistent weak vapour of naphthalene in houses is to be avoided, as it will not prevent invasions of red spider, and may cause serious injury to plants.

(VII.) Red Spider in the cucumber houses at the Experimental Station has, for the second season, been kept under complete control by fumigations at intervals of not less than one month, except in cases where two fumigations were carried out at short intervals for special investigations.

**Red Spider on Tomatoes.**

Serious outbreaks of Red Spider on tomatoes have occurred again this season, and at the Experimental Station the old block of houses and the carbon dioxide chambers were very severely attacked.

In August a comparison of the severity of infestation in the experimental plots was made, but no evidence was forthcoming that any particular manurial treatment tended to check the spider.

Amongst the varieties grown, the " Comet × Manx Marvel " hybrid, " Comet " and " Radio " were least affected ; " Best of All," " Clarke's Masterpiece " and " Tuckswood " most severely.

Individual plants through the houses, and especially in the new block, with strong, dark stem, and large leaves, showed little damage from spider attack. These facts point strongly to the advisability of cultural experiments in the control of Red Spider on tomatoes.

**Naphthalene Fumigation.**

Volatilisation of naphthalene from fumigators was very uncertain in effect, and least risk of injury was experienced from broadcasting grade 16 naphthalene at the rate of 1-2 ounces per

square yard over the whole soil surface, and keeping the ventilators closed during the following day. It is estimated that this treatment, especially if combined with shading of the houses, does not lead to the loss of more than one truss of tomatoes under severe conditions of heat.

Dusting with various forms of sulphur and mixtures of these with naphthalene were not efficient.

Efforts to obtain a more volatile form of naphthalene with a view to effecting fumigation on a single night failed entirely. It is concluded that naphthalene is not a suitable fumigant for tomato house conditions, on account of low temperatures, risk of damage through keeping ventilators closed during the day, and danger from mildew if warm, moist atmospheres are created.

Dusting experiments with nicotine up to 3% absorbed on calcium carbonate and magnesium carbonate gave no results.

Green oil, from coal tar distillation, when volatilised from fumigators, had a marked effect on Red Spider at low temperatures, but some of the substances contained in the oil were very injurious to plants, and efforts are being made to extract the latter.

## Woodlice.

On pages 102 and 103 of the Tenth Annual Report for 1924, an account was given of a poison-bait consisting of oatmeal, 90%, white flour, 5%, and Paris Green, 5%, which had been found useful in protecting tomato seedlings from attack by woodlice. Experiments on cucumber borders with this bait had not then been carried out.

With a view to testing the bait, together with others containing different proportions of the ingredients, portions of border from 14 to 20 feet in length were treated at the rate of one ounce of each bait to the square yard of border, mangolds being placed at equal intervals on each border to give an idea of the number of woodlice present.

| | Constituents of Bait. | | | Dead Woodlice collected after | Living Woodlice on Mangolds after | |
|---|---|---|---|---|---|---|
| | Coarse Oatmeal. | Flour. | Paris Green. | 12 hours. | 12 hours. | 36 hours. |
| No. 1 ... | 90 | 5 | 5 | 27 | 8 | 2 |
| No. 2 ... | 95 | — | 5 | 7 | 5 | 7 |
| No. 3 ... | 75 | 20 | 5 | 3 | 2 | 3 |
| No. 4 ... | — | 95 | 5 | 29 | 1 | 1 |
| No. 5 ... | — | 90 | 10 | 17 | 7 | 3 |
| No. 6 ... | 90 | — | 10 | 50 | 6 | 3 |
| No. 7 Control untreated. | | | | | | |

Comparing the numbers of living woodlice collected from the mangolds with those found dead on the borders, the percentages killed were as follows :—

No. 1, 73 ; No. 2, 37 ; No. 3, 37 ; No. 4, 93 ; No. 5, 63 ; No. 6, 85.

Though not much reliance can be placed on such figures, it was indicated that with a coarse substance like oatmeal it is advantageous to increase (No. 6) and with fine flour (No. 4) to decrease the Paris green content.

Tested on a larger scale, however, not much difference resulted in the use of oatmeal and flour each mixed with 5% Paris green. As both these substances require some 4 lbs. to be used on 100 feet of cucumber border in order to obtain good distribution, and seeing that woodlice are not attracted particularly to any of these baits, merely feeding upon that which they first encounter, *Bran* was given a trial, as this is cheap and goes twice as far as the other materials.

Using dry bran with 5% Paris green, results were disappointing, for only some 40% of the woodlice were killed on a 100 ft. cucumber border. The Paris green content was increased to 10%, and a still lower percentage of deaths were recorded.

On decreasing the Paris green content to 3%, excellent results were immediately obtained. In April the number of woodlice in the Experimental Station houses was alarming, and a further increase was inevitable, as the females had young in their brood pouches. The bait made by thoroughly mixing 28 lbs. of bran and 1 lb. powdered commercial Paris green was distributed throughout the houses, using 4 lbs. mixture to 100-foot house. The results were so satisfactory from one application that a second treatment was not called for until July. In August a number of woodlice appeared in the houses, probably having gained access from outside, and a third application was made. When the borders were cleared in October not more than 100 woodlice were seen, whereas in previous seasons they could be collected by the thousand at this time. The chief advantage in connection with this method of control showed itself in the condition of the collars of the cucumber plants, which was far better than in any previous season. The total amount of Paris green received in the three applications amounted to not more than 1/20th ounce per square yard, and it is hardly possible that this amount could affect growth in any way.

The bait has been used upon a number of nurseries in different districts and it appears that the treatment has been entirely successful in reducing the heaviest infestation to such an extent that the woodlice were no longer a menace to good growing.

One of the severest infestations occurred in some isolated cucumber houses which had been erected in recent years on old grassland. At the beginning of May, some hundredweights of the common pill-woodlouse (*Armadillidium vulgare Lat*) had been collected from the houses by trapping with inverted seed-boxes, and still the animals were present in such numbers that the plants were threatened with complete destruction. This woodlouse is usually uncommon in cucumber houses, but in this case the true cucumber house woodlouse (*A. speyeri* Jackson) appeared to be absent. Two applications of the Paris green bait were made, and the houses were cleared of woodlice, the second crop of cucumber plants being unaffected by them.

This bait also kills crickets, and other species of woodlice such as *Porcellio laevis Lat* and *P. rathkei Br.*, both found in cucumber houses.

The bait should be used early in the season, before the woodlice begin to breed, as towards the end of the season they do not appear to feed upon the bran to such an extent, perhaps owing to the abundance of food round them in the decayed borders.

For the convenience of growers, Circular No. 3, issued in June, 1925 from this Experimental Station is repeated with slight alteration :—

## The Control of Woodlice in Glasshouses.

**Poison Bait.**

One pound commercial Paris green powder is mixed thoroughly with 28 lbs. dry bran. This bait is broadcast over the whole soil surface at the rate of about ½ oz. to the square yard.

For pot-plants on staging, a little of the bait should be sprinkled over each pot, in addition to broadcasting under the staging, care being taken not to place large quantities of the bait on foliage.

Watering should be carried out before broadcasting so that the bait remains dry for as long a time as possible.

*Caution.*—Paris green being poisonous, a glove should always be used when broadcasting the bait, or when otherwise handling it, and it is advisable to obtain the bait ready-made.

*Note.*—There is no advantage in using a greater proportion of Paris green in the bait. The efficiency of the bait is largely dependent upon its wide and even distribution over the soil

surface. Paris green is poisonous to livestock, and should not be used in gardens, etc. For this purpose a light dressing of a fine flake pure commercial naphthalene is recommended.

The mixing with the bait of finely divided substances such as flour or middlings is to be avoided. A bait consisting of equal parts of bran and middlings with 3% Paris green was not so effective as the bait above described. When used to pack round the collars of 12 cucumber plants towards the end of the season death of the plants resulted within a week, whereas the original bait applied similarly did not appear to have a deleterious effect.

The treatment of the stems of the plants with large quantities of the bait is in any case to be avoided, as any unevenness in the mixing of the ingredients might entail serious damage.

**White-Fly** (*Trialeurodes vaporariorum*, Wstw.).

Efforts to simplify the cyaniding of tomato houses for the control of white-fly have met with considerable success.

In the practice of jar-cyaniding much time is employed in weighing out and measuring the sodium cyanide and sulphuric acid ; in large nurseries jars are often difficult to obtain in sufficient quantities and much labour is involved, as one man for each house is required to drop the cyanide into the acid. Further, the hydrocyanic acid gas is evolved very rapidly, and on windy nights this tends to produce high concentrations of gas in restricted areas of the houses.

Sodium cyanide in a fine state of division can be decomposed by mixing it with three times its weight of sodium bicarbonate. The evolution of gas is slow, and the use of this mixture has enabled a comparison to be made between the effects on white-fly of fast and slow generation of gas.

On approach of the gas, even in very small quantities, the adult fly are anæsthetised almost immediately in both cases, so that it is improbable that a rapid generation tends to prevent the insects closing their stigmata.

By quick generation from 1/5th to $\frac{1}{4}$ oz. sodium cyanide per 1,000 cubic feet space, about 90% of the scale stages are killed, while with the slow generation using $\frac{1}{4}$ oz. sodium cyanide, the mortality amongst the scales is considerably less. In both, practically a total kill of adults is obtained. Owing to large numbers of adult fly on weeds in the vicinity, tomato houses are bound, shortly after a fumigation, to become re-infested to a slight degree, and the eggs not being killed by either process, there is little difference in the measure of control finally obtained

by the two processes. On the other hand, from an economic outlook, the scattering upon the paths of houses of a powder which generates the gas slowly is preferable, as one man can treat several houses of a block without inconvenience, and continuous slow evolution of gas decreases risk of damage to plants in presence of air currents.

Experiments have been carried out with different quantities of powdered sodium cyanide mixed with sufficient sodium bicarbonate to ensure decomposition of the former, scattered on the paths of houses and results are here given :—

| Mixture per 1,000 cubic feet. | | Houses Treated. | | Effect on White Fly. | |
|---|---|---|---|---|---|
| Sodium Bicarbonate. | Sodium Cyanide. | No. | Total Capacity. | Scales. | Adults. |
| 1. 6/7th oz. | 1/7th oz. | 4 | 172,000 c. ft. | Not killed ... | A number recover. |
| 2. 5/6th oz. | 1/6th oz. | 4 | 172,000 c. ft. | Not killed ... | Killed. |
| 3. 4/5th oz. | 1/5th oz. | 13 | 390,000 c. ft. | Not killed ... | Killed. |
| 4. 3/4th oz. | 1/4th oz. | 6 | 252,000 c. ft. | Good proportion killed | Killed |
| 5. 3/4th oz. | 1/4th oz. | 1 | 24,000 c. ft. | Killed ... | ... Killed |
| 6. 1 oz. | 1/3rd oz. | 1 | 24,000 c. ft. | Killed ... | ... Killed |

In experiments (1) to (4) there was no injury to the plants, which were decidedly on the soft side, and it is doubtful if jar cyaniding could have been resorted to without considerable injury in experiment (3).

In experiments (5) and (6) scorching of no very serious nature resulted, due in the latter case to excess of gas evolved, and in the former to the plants not having been sufficiently dry at the root.

A mixture of $\frac{3}{4}$ ounce sodium bicarbonate and $\frac{1}{4}$ ounce sodium cyanide per 1,000 cubic feet gave the best results, and to obtain good control of white-fly these amounts need not be varied in accordance with conditions of plant-growth or of tightness of house.

Directions for the fumigation of tomato houses by slow-process generation of hydrocyanic acid gas are now given :—

**Materials.**

Dry powdered sodium bicarbonate and high grade sodium cyanide (98% purity) in a fine state of division, are thoroughly mixed in proportion of 3 parts sodium bicarbonate and 1 part sodium cyanide by weight. The mixture should be obtained ready made from a manufacturer.

**Amount to be used.**

One ounce of the mixture to every 1,000 cubic feet space is distributed upon the paths, which should be dry. One operator can treat a considerable number of houses in a block single-handed.

**Precautions for the Operator.**

The mixture should not be handled; when distributing, it should be shaken from a large tin, containing sufficient quantity for a single house, the operator walking backwards to avoid getting the powder upon his clothing. The ventilators should be kept open during distribution, and closed immediately after. The house should be locked up for the night.

**Precautions for the Plants.**

The mixture should be distributed at dusk, water having been withheld from the plants, so that they require moisture at the root. Moisture in the house, and fumigation on rainy nights are to be avoided.

Ventilators should be opened at dawn next morning and kept open as long as conditions allow during the next day. The residual sodium carbonate may be left on the paths. Fumigation is best carried out at low temperatures, but heat may be put on if conditions demand it.

**The Effect of Tetrachlorethane Vapour on Chrysanthemums.**

It has been known for some time that certain varieties of Chrysanthemum are susceptible to injury from the vapours of tetrachlorethane—a liquid used for the control of White-Fly.

Experiments carried out this season show that susceptibility to injury is not connected with colour of the flower, as was originally suggested, and scorching may be due to direct action of the vapour upon some substance contained in the tissues, and variably distributed in different varieties, but constantly distributed in the same variety.

Ten ounces tetrachlorethane poured on the path of a glass house of 1,000 c. ft. capacity were used, and conditions of moisture in the atmosphere and at the root of the plants, together with temperature, were varied in each experiment.

The watering of plants before fumigation and a cool temperature rendered the plants slightly less reactive to the vapours, but these conditions do not prevent injury.

The following is a list of varieties used, arranged under their flower-colours, with notes relating to the effect in each case.

*White Varieties.*

| | |
|---|---|
| Favourite ... ... ... | No apparent injury. |
| Cheshunt ... ... ... | Buds probably injured. |
| Heston ... ... ... | ,, ,, ,, |
| Sanctity ... ... ... | Slight injury to buds; lower leaves severely scorched. |
| Roi de Blanc ... ... | Buds destroyed; leaves severely scorched throughout. |
| Debutant ... ... ... | ,, ,, ,, ,, |

*Yellow Varieties.*

| | |
|---|---|
| Nogoya ... ... ... | No apparent injury. |
| Beauty of Exmouth ... | Buds probably injured. |
| Mrs. R. C. Pulling ... | ,, ,, ,, |
| Amber ... ... ... | Buds probably uninjured; scorched patch on leaves near growing point. |
| Almans ... ... ... | Buds destroyed; only upper leaves scorched. |
| Golden Mensa ... ... | Buds destroyed; upper and mid leaves scorched. |
| Cranford ... ... ... | Buds destroyed; leaves scorched throughout. |
| Winter Gem ... ... | Buds destroyed; leaves severely scorched throughout. |
| Gold-finder ... ... | ,, ,, ,, ,, |

*Red Varieties.*

| | |
|---|---|
| Kathleen May ... ... | No apparent injury. |
| Gladys Lane ... ... | ,, ,, |
| Lady Violet Beaumont ... | Lower leaves very slightly scorched. |
| Amoral ... ... ... | Mid and lower leaves scorched. |

*Crimson Varieties.*

| | |
|---|---|
| September Glory ... | Buds destroyed; leaves slightly scorched throughout. |
| Baldock ... ... ... | Buds destroyed; leaves severely scorched throughout. |

*Bronze Varieties.*

| | |
|---|---|
| Verona ... ... ... | Possible slight injury to buds only. |
| Almarante ... ... | Buds and upper leaves unhurt; mid and lower leaves scorched. |
| Betty Spark ... ... | Buds destroyed; upper leaves slightly, lower leaves severely scorched. |
| Harvester ... ... | Buds destroyed; leaves severely scorched throughout. |
| Ceddie Mason ... ... | ,, ,, ,, ,, |
| Brilliant ... ... ... | ,, ,, ,, ,, |

*Pink Varieties.*

| | | | | | |
|---|---|---|---|---|---|
| M. Moselle Charvet | ... | Buds destroyed; | leaves | severely | scorched throughout. |
| Winter Cheer ... | ... | ,, | ,, | ,, | ,, |
| Dr. Englehardt ... | ... | ,, | ,, | ,, | ,, |
| Ivy Gay ... ... | ... | ,, | ,, | ,, | ,, |
| Ethel Thorpe ... | ... | ,, | ,, | ,, | ,, |

After fumigation, all the pink varieties subsequently died; also the varieties Roi de Blanc, Gold-finder, Baldock, Winter Cheer, Harvester, Ceddie Mason and Brilliant. The other varieties which were severely scorched died down and threw new growth from the roots. The type of leaf-scorch varied according to the position of the leaves on the plant, but were quite constant for plants of the same variety. So striking was this, that it was almost possible to tell the variety from the nature of the injury.

As white-fly seldom damages chrysanthemums and appears only to collect upon them on approach of winter, any fumigation with tetrachlorethane is to be avoided, as the flowering capacity of the plants may be greatly restricted, even though no immediate damage is noticeable.

# Chemical Investigations.

By O. Owen.

**Soil Analysis.**

A large number of soils from commercial nurseries have been examined during the year. In all cases where the soils have been under cultivation during four years or more, analysis shows that the amount of lime present is sufficient for several crops. In all "new" soils, *i.e.*, those which had been covered with glass recently, there was no trace of lime in the form of carbonate. In soils which have been under cultivation for a period of years, white granules can be picked out. Whilst the actual composition of these granules is not known, they invariably contain a high proportion of calcium carbonate, and in one or two soils the amount of this material present has corresponded to a dressing of over 50 tons per acre of chalk. In such cases there appears to be little need of further addition of lime in any form.

It is a practice with most growers to apply lime every year When the amount so added is small there is nothing to be said When, however, the amount added exceeds 2 tons of quicklime per acre, it is probable that there is a certain amount of waste, since the material only accumulates in the form of carbonate.

On the old plots at the Experimental Station the lime content is of the order of 0.3% to 0.5% of calcium carbonate. This suffices to give a good crop and is the result of an annual application of two tons per acre of quicklime. Even on heavy soils there is probably very little or no benefit to be derived from the heavy applications of lime which some growers favour, and a small and regular saving can be effected on many nurseries by cutting down the lime dressing when it exceeds the two tons already mentioned.

Another soil constituent which is probably used in excess is phosphoric acid. It is common practice to apply this ingredient in both the base and the top dressings. The amounts and forms used by different growers vary, but without exception, cultivated tomato soils always show a high percentage of phosphoric acid. The amount of phosphoric acid removed by the plant is actually much less than the amount of potash or nitrogen so removed, and yet, it is customary to apply much more phosphate than potash. The phosphate experiments on the Station plots show that neither the quality nor the quantity of the crop are influenced appreciably by variation in the quantity of phosphate applied—the plot receiving no phosphatic top-dressing comparing very favourably with plots receiving quite high proportions of phosphates.

Thus it should be possible to reduce phosphatic dressings without detriment to the crop.

The analysis of soils will often show a deficiency in nitrogen and sometimes in potash, and addition of either or both of these will result in an improvement in the crops With phosphates, however, it is never our experience that their addition to a cultivated soil has improved a tomato crop. While phosphates are not likely to produce detrimental effects, it is certain that for tomatoes this nutrient is the least important of the three which we apply in our manures.

A query which we often meet with is that regarding the suitability of a particular soil for tomato growing. During the last three years we have examined a large number of soils with a view to answering this question. The majority of these soils have come from the Lea Valley, but a number from other parts of the country have also been examined. Probably the fractions which concern a nurseryman most are the fine particles which are designated "clay" and "fine silt." The amounts of these fractions vary very appreciably in the various nurseries from which samples have been taken. It appears that, providing there is a reasonable depth of soil and the site is desirable, the importance of the soil type is liable to be over estimated. Of course, a stiff clay will not be chosen if an alternative is possible, but analysis shows the soils from a number of flourishing nurseries within reach of the Station to be stiff clays. These have been improved by suitable dressings of stable manure and lime.

**The Amounts of Potash, Phosphoric Acid and Nitrogen Removed by a Tomato Crop.**

The experiments on the nutrition of tomatoes at the Station have shown that the plants react to dressings of potash and nitrogen. This is the experience during several seasons, although it is not yet possible to decide on the ideal quantities of these two substances to be used. While it is possible to correlate the quantity and quality of the crop with the amount of nitrogen or potash added, no relation appears to connect quality or quantity of crop with the phosphoric acid added. Indeed, there is little difference between crops on plots to which phosphatic fertilisers have been given and those from which they have been withheld. Furthermore it has never been our experience that an indifferent tomato crop growing in cultivated soil has benefited by the addition of phosphates.

These facts have suggested the desirability of obtaining information concerning the amounts of these plant foods which are removed from the soil by a crop.

With this end in view, plants from a plot receiving standard treatment (K3) have been analysed during the year. A sample of soil from K3 showed the following analysis :—

| | |
|---|---|
| Total nitrogen ... ... ... | 0.319% |
| Total potash ... ... ... | 0.440% |
| " Available " potash... ... ... | 0.097% |
| Total phosphoric acid ... ... | 0.940% |
| " Available " phosphoric acid ... | 0.129% |

For comparison the same number of plants were set aside in a " starved " plot (K2) and analysed in the same way.

The soil in K2 showed the following analysis :—

| | |
|---|---|
| Total nitrogen ... ... ... | 0.233% |
| Total potash ... ... ... ... | 0.258% |
| " Available " potash... ... ... | 0.0039% |
| Total phosphoric acid ... ... | 0.437% |
| " Available " phosphoric acid ... | 0.090% |

During the season the plants in K3 gave a crop of 30.49 tons per acre and those in K2 one of 19.14 tons per acre.

In each plot nineteen plants were selected so that they were not interfered with by plants in adjoining plots. This was necessary to avoid the possibility of plant foods being washed in from surrounding plots. Both batches of plants were treated in the usual commercial manner adopted throughout the nursery. All side shoots and leaf-trimmings were reserved, and, with all the fruit, were brought to the laboratory. There they were weighed and analysed by the usual methods. Roots were neglected in both cases.

The full details of weights, date of picking and analysis are shown in tables 1 and 2. All the weights shown are in grams.

Examination of these tables gives the following facts for the two plots :—

## Table I.—Analysis of Fruit and Foliage from 19 plants in K3.

| Date of Picking. | Green Weight. | Dry Weight. | In Dry Matter. | | | | Total Ash. | Total $K_2O$. | Total $P_2O_5$. | Total N. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | % Ash. | % N. | % $K_2O$. | % $P_2O_5$. | | | | |
| 21/4/25 | 245.5 | 23.28 | 14.50 | 5.779 | 4.467 | 1.029 | 3.368 | 1.004 | .2396 | 1.346 |
| 28/4/25 | 250.7 | 22.96 | 30.83 | 4.162 | 8.642 | .8445 | 7.877 | 2.308 | .2250 | 1.064 |
| 4/5/25 | 39.6 | 3.68 | | | | | | | | |
| 12/5/25 | 515 | 44.03 | 41.00 | 3.221 | 12.23 | .7263 | 18.05 | 4.944 | .3198 | 1.421 |
| 19/5/25 | 240 | 20.12 | 36.00 | 2.733 | 9.759 | .4752 | 7.243 | 1.963 | .0956 | .55 |
| 16/6/25 | 614.4 | 53.08 | 41.00 | 2.787 | 7.743 | .6213 | 21.75 | 4.110 | .3295 | 1.479 |
| 3/7/25 | 1480 | 143 | 30.70 | 2.997 | 8.226 | .4687 | 43.89 | 11.76 | .6701 | 4.285 |
| 29/7/25 | 5095 | 543 | 28.56 | 3.114 | 7.884 | .4692 | 155.1 | 40.64 | 2.548 | 16.91 |
| 26/8/25 | 5436 | 550 | 27.49 | 3.244 | 7.145 | .4789 | 151.2 | 39.30 | 2.634 | 17.84 |
| 16/9/25 | 3451 | 325 | 26.34 | 4.241 | 7.593 | .7025 | 85.63 | 24.68 | 2.283 | 13.78 |
| 23/10/25 | 11493 | 976 | 26.42 | 5.022 | 7.565 | .7745 | 257.8 | 73.81 | 7.734 | 49.00 |
| Total ... | 28860 | 2704 | — | — | — | — | 751.908 | 204.519 | 17.0786 | 107.675 |
| Fruit ... | 46117 | 2838.32 | 13.02 | 2.448 | 4.980 | .7558 | 369.6 | 141.4 | 21.45 | 69.48 |
| Relative | — | — | — | — | — | — | — | 8.98 | 1 | 4.59 |

## Table II.—Analysis of Fruit and Foliage from 19 plants in K2.

| Date of Picking. | Green Weight. | Dry Weight. | In Dry Matter. | | | | Total Ash. | Total $K_2O$. | Total $P_2O_5$. | Total N. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | % Ash. | % N. | % $K_2O$. | % $P_2O_5$. | | | | |
| 21/4/25 | 167.2 | 15.64 | 18.56 | 5.105 | 2.491 | 1.089 | 2.891 | .3896 | .1704 | .795 |
| 28/4/25 | 207 | 18.51 | 30.46 | 2.951 | 2.775 | .5618 | 5.771 | .5137 | .1004 | .5462 |
| 12/5/25 | 550 | 52.96 | 35.11 | 2.646 | 1.629 | .6950 | 18.60 | .8628 | .3682 | 1.402 |
| 19/5/25 | 70.54 | 8.47 | 34.39 | 2.964 | 1.321 | .7365 | 21.16 | .8134 | .4534 | 1.825 |
| 16/6/25 | 568.4 | 53.08 | | | | | | | | |
| 3/7/25 | 810 | 78 | 31.54 | 2.882 | 1.619 | .4849 | 24.60 | 1.263 | .3782 | 2.253 |
| 29/7/25 | 699 | 106.5 | 30.84 | 2.795 | 1.361 | .6504 | 32.78 | 1.450 | .6928 | 2.977 |
| 16/9/25 | 1812 | 428 | 35.42 | 2.979 | 1.945 | .7377 | 148.1 | 8.328 | 3.157 | 12.75 |
| 23/10/25 | 5716 | 800 | 22.06 | 2.737 | 2.966 | .4555 | 176.5 | 23.73 | 3.644 | 21.92 |
| Total ... | 10600 | 1561 | — | — | — | — | 430.402 | 37.3505 | 8.9644 | 44.4682 |
| Fruit ... | 27376 | 1414.4 | 5.91 | 3.468 | 1.091 | .6952 | 83.66 | 15.425 | 9.836 | 49.06 |
| Relative | — | — | — | — | — | — | — | 2.8 | 1 | 5 |

**K3.**

For a marketable crop of 46,117 g. of fruit, leaves and stalks to the amount of 28,860 gms. were necessary. In the fruit were 141.4 g. potash, 21.45 g. phosphoric acid, and 69.48 g. nitrogen. In the leaves and stalks the amounts were 204.52 g. potash, 17.08 g. phosphoric acid and 107.68 g. nitrogen. Thus altogether the production of the fruit entails the removal of 345.92 g. potash, 38.53 g. phosphoric acid, 177.16 g. nitrogen.

On this basis a 40-ton crop would remove :—
672 lbs. potash, 75 lbs. phosphoric acid, 344 lbs. nitrogen apart from the amounts removed from the soil and retained by the roots.

Further, the ratio of the three plant foods is :—

8.98 potash, 1 phosphoric acid, 4.59 nitrogen.

Thus, the amount of phosphoric acid removed by the plant is easily the lowest of the three nutrients which are supplied in fertilisers. This makes it all the more difficult to understand why a very popular top-dressing should be made up to give the following ratio :—

1.2 potash, 1.95 phosphoric acid, 1 nitrogen.

It is true that phosphates are, as a rule, cheap, but these figures and the results of the experiments on phosphate nutrition suggest that they may constitute a serious extravagance.

Since the crop removes so little phosphoric acid, it is likely that in a soil which does not receive phosphates regularly there would be a sufficient reserve of this material to nourish a plant. This probably explains why soils which receive no phosphates for two or three years are practically as good as those which receive an annual dressing of phosphatic fertilisers.

Another point of interest is the composition of the fruit. From Table 1 it is calculated that it contains 93.5% of water, 3.07% potash, 0.465% phosphoric acid and 1.51% nitrogen.

**K2.**

This plot has never received any manurial treatment since 1917. Here a crop of 27,376 g. of fruit was accompanied by 10,600 gms. of leaf and stalk. 15.4 g. potash, 9.8 g. phosphoric acid, and 49.1 g. nitrogen were removed in the fruit and 37.4 g. potash, 9.0 g. phosphoric acid and 44.5 g. nitrogen by the leaves and stalks.

Thus the complete removal consisted of :—

52.8 potash, 18.8 g. phosphoric acid, and 93.1 g. nitrogen.

Here the ratio is as follows :—

2.8 potash, 1 phosphoric acid, 5 nitrogen.

The soil in this case must be seriously depleted of plant foods, and we may assume that the plant will only take what is available. It would appear that the shortage of potash is made up by the plant by a relatively bigger intake of phosphoric acid and nitrogen.

It is noteworthy that here the fruit contains 94.9% of water, 0.56% potash, 0.359% phosphoric acid, 1.79% nitrogen. Whilst the foliage from K3 contains 90.6% of water, that from K2 contains only 85.3%. The low value for the latter is probably explained by the fact that at the end of the season the " tops " made very poor growth and the shoots were often dead and had commenced to dry before they were taken off.

It is interesting to compare the amounts and distribution of the three nutrients under the conditions prevailing in plots K2 and K3 respectively. The amounts removed per plant are calculated from Tables 1, and 2 and are given in Table 3.

**Table 3.**

AMOUNTS REMOVED PER PLANT.

| | Potash $K_2O$ | Phosphoric Acid $P_2O_5$ | Nitrogen. N. | Ratios. | | |
|---|---|---|---|---|---|---|
| K2 ... | 2.78 | 9.89 | 4.9 | 1.37 | 4.87 | 2.42 |
| K3 ... | 18.21 | 2.03 | 9.32 | 8.98 | 1 | 4.59 |

The difference in the ratios is remarkable. This is very difficult to explain and it is only speculation to suggest that the low intake of potash allows the plants in K2 to take in a larger proportion of phosphoric acid and nitrogen than is necessary for the normal plants in K3. The distribution of the three nutrients in the two cases is as follows :—

**Table 4.**

| | Potash | | Phosphoric Acid | | Nitrogen | |
|---|---|---|---|---|---|---|
| | % in Fruit | % in leaves, etc. | % in Fruit | % in leaves, etc. | % in Fruit | % in leaves, etc. |
| K2 ... | 29.2 | 70.8 | 52.3 | 47.7 | 52.4 | 47.6 |
| K3 ... | 40.9 | 59.1 | 55.7 | 44.3 | 39.2 | 60.8 |

The effect of starving in K2 is well shown in this table. It is clear that relatively more of the total potash and phosphoric acid are taken up by stem and leaves at the expense of the fruit. In the case of the nitrogen, however, the state of affairs is reversed —more being found in the fruit and less in leaves and stalks.

## The Action of Some Chemical Agents on Colletotrichum tabificum.

O. Owen.

In recent reports Dr. Bewley has described a root disease of the tomato caused by a fungus *Colletotrichum tabificum*. He found, after systematic search, that this fungus is almost invariably present in glasshouse soils, in which tomatoes have been grown continuously for several years. *C. tabificum* is not a vigorous parsite, but its action is none the less effective. It works slowly during the year, gradually infecting and destroying tomato roots, and is no doubt responsible for reduced yields.

It has long been known that efficient steaming will eliminate this fungus from the soil, but sterilisation by cresylic acid and other disinfectants does not control it. This may be due to the difficulty of distribution. A disinfectant may be applied by washing into the soil, by dilution with or absorption on an inert material such as soil or ashes or by direct application of a dilute emulsion. By none of these methods is any efficient admixture with the soil secured.

Large scale experiments on sterilisation with chemicals in nurseries have been carried out during several years, but have not provided the information expected. Hence it was considered desirable to investigate the action of chemical agents on a single organism. *C. tabificum*, with its hard, resistant sclerotium, was considered suitable for this purpose.

The method involved immersing, for a given time, a sclerotium in the liquid to be tested. At the end of the time the sclerotium was removed and washed in three changes of sterile water and finally placed on a slope of nutrient medium. Where the chemical had killed the sclerotium no growth was observed after placing it on the nutrient. Where growth did take place it was considered that in the time of exposure the chemical had not affected the sclerotium.

Cresylic acid in the ordinary form and in the form of an emulsion in soft soap were examined in some detail. The results are as follows :—

**Cresylic Acid.**

The material was " pure " cresylic acid.

17 hours' exposure—no growth.

17 ,, down to 16 minutes—no growth.

15 minutes—no growth.

5—11 minutes' exposure—growth.

So that an exposure of 15 minutes prevents subsequent growth.

**Aequeous Cresylic Acid.**

A saturated aequeous solution of cresylic acid was made by shaking an excess of the acid with distilled water and keeping at 25°C. The clear supernatant solution was used. Results were as follows :—

17 hours' exposure—no growth ;

5 ,, ,, —,, ,,

Saturated aequeous solution, diluted down to 40%, 17 hours' exposure—no growth.

**Emulsified Cresylic Acid.**

This emulsion was made by heating a gallon of " pure " cresylic acid and dissolving in it 8 lbs. of " pure " potash soft soap. The emulsion so prepared is quite stable at high dilutions. The advantage of cresylic acid in this form is, of course, the fact that it can be diluted.

| | | |
|---|---|---|
| 17 hours' exposure ... | The strong emulsion ... ... | No growth |
| ,, ,, ... | Concentration down to 0.3% by Vol. | ,, |
| ,, ,, ... | 0.25% by vol. and below ... | Growth |
| 2-7 hours' exposure ... | 0.4% ,, ... ... ... | Growth |
| 15 mins.-2 hrs.' exposure | 100% ... ... ... ... | No growth |
| 5-12 mins.' exposure ... | 100% ... ... ... ... | Growth |
| 15 mins. ... ... ... | 80%-40% by vol. ... ... ... | Growth |

Preliminary experiments were made to determine whether the vapour of cresylic acid had any effect on the fungus. For this purpose a small test tube containing cresylic acid was fixed inside a large plugged tube containing potato agar, so that the cresylic acid vapour could permeate through the air in both tubes. Sclerotia were placed on the agar and the whole apparatus kept in an incubator at 25°C. In no case was the growth of the sclerotia affected. Hence it does not appear that the vapour of this disinfectant has any controlling effect on the organism.

Other substances which were tested by immersing sclerotia in them are shewn in Table (5) in which are summarised the results.

**Table 5.**

| Substance | Exposure | Concentration | Result |
|---|---|---|---|
| Phenol ... ... | 17 hours ... | 4%—0.3% | ... No growth |
| „ ... ... | „ ... | 0.2% | ... Growth |
| „ ... ... | 1-5 „ ... | 0.4% | ... „ |
| „ ... ... | 6 „ ... | 0.4% | ... No growth |
| Tetrachlorethane .. | 17 „ ... | neat | ... „ |
| „ ... | 1-3 „ ... | „ | ... Growth |
| Raw Fusel Oil ... | 17 „ ... | „ | ... No growth |
| Iodine Soln. ... | 17 „ ... | approx. 0.45% | ... „ |
| „ „ ... | 17 „ ... | 0.40—0.10% | ... „ |
| Potassium Permanganate... | 17 „ ... | 1.134 n/10 | ... Growth |
| Formalin ... ... | 1-17 „ ... | neat—12.5% | ... No growth |
| Hydrogen Peroxide ... | 17 „ ... | 20 vol. | ... „ |
| „ ... | 1-2 „ ... | „ | ... Growth |
| Aniline ... . . | 17 „ ... | neat | ... „ |
| Bromobenzene ... | 17 „ ... | „ | ... „ |
| Chlorobenzene ... | 17 „ ... | „ | ... „ |
| o-Dichlorobenzene | 17 „ ... | „ | ... „ |
| Nitrobenzene ... | 17 „ ... | „ | ... „ |
| "Higher Phenols" | 17 „ ... | „ | ... „ |
| o-Toluidine ... | 17 „ ... | „ | ... „ |
| di-methylaniline ... | 17 „ ... | „ | ... „ |
| Pyridine ... ... | 17 „ ... | „ | ... „ |
| Quinoline ... ... | 17 „ ... | „ | ... „ |
| Pentachlorethane.. | 17 „ ... | „ | ... „ |
| Trichlorethylene... | 17 „ ... | „ | ... „ |
| Paraldehyde ... | 17 „ ... | „ | ... No growth |

# Carbon Dioxide Investigations.

O. Owen and T. Small.

These investigations were continued. Last year there was a definite increase in crop. This year an attempt was made to corroborate that result and also to test whether cucumbers would respond in a similar manner.

X1 and X2 were each planted with 14 cucumber plants. Variety—Butcher's Disease Resister.

X3 and X4 were each planted with 56 tomato plants, variety, Tuckswood, as distinct from the variety Rochford's Improved Ailsa Craig, which was used last year.

The treatment in the chambers was as follows :—

X1.—Cucumber control. No carbon dioxide supplied.

X2.—Cucumbers receiving an average concentration of 0.9% carbon dioxide daily from 9.30 a.m. to 10.30 a.m. after planting out.

X3.—Tomatoes receiving an average concentration of 0.6% carbon dioxide daily from 8.30 a.m. to 9.30 a.m. after planting out. This was a repetition of the treatment given in X2 last year.

X4.—Tomatoes. Control for X3. No carbon dioxide supplied.

All normal cultural conditions such as temperature, ventilation and manurial treatment were kept comparable in the various chambers. Temperature records were taken throughout the season and the average temperature was found to be approximately the same in treated and untreated chambers.

The dates of the cultural operations were as follows :—

Seeds sown December 29th, 1924.

Tomato plants planted March 3rd, 1925.

Cucumber plants planted March 10th, 1925.

Carbon dioxide treatment commenced March 24th, 1925.

The results are summarised in Table I.

**Table I.**

| Chamber | Pounds per Plant | Tons per Acre |
|---|---|---|
| X1. Cucumber. Control ... ... ... | 38.45 ... | — |
| X2. Cucumber 0.9% after planting out ... | 44.49 ... | — |
| X3. Tomatoes 0.6% after planting out 8.30 a.m. to 9.30 a.m. ... ... | 7.28 ... | 43.68 |
| X4. Tomatoes. Control ... ... ... | 5.81 ... | 34.86 |

These results show that, as in last year's experiments, the tomato crop is increased by the treatment and that an increase in the cucumber crop is obtained. Little difference in the appearance of the plants was evident till the late part of the season. Then it was noticed that the treated tomato plants were somewhat fresher in appearance and were certainly taller than the untreated plants. The treated cucumber plants lived longer than the untreated plants. Tables III. and IV. show the detailed records of the tomato crops. It is clear from these tables that the increase in crop is mostly evident in June and September.

It is difficult to explain why an increase should occur in September. As to the June increase the question immediately arises as to whether it is necessary to treat the plants after this month. This point will be among those to be investigated in 1926.

Table II. shows that in the case of cucumbers the increase is confined almost entirely to the months of June and July.

**Table II.**

| | Pounds per plant | | | | | | |
|---|---|---|---|---|---|---|---|
| Series | April | May | June | July | Aug. | Sept. | Total |
| X1. | 4.23 ... | 10.93 ... | 6.73 ... | 6.68 ... | 9.63 ... | 0.25 ... | 38.45 |
| X2. | 4.64 ... | 10.98 ... | 8.51 ... | 10.52 ... | 9.56 ... | 0.28 ... | 44.49 |

## Experiments with Commercial Apparatus.

Experiments with this apparatus were continued. The apparatus used last year was dismantled and a new and larger model installed. The principle of the new apparatus is similar to that of the former one and is explained in the report for last year.

For the experiments a glasshouse of 23,600 cubic feet capacity and containing 1,040 Ailsa Craig tomato plants was used. The gas generated by the apparatus was pumped into the house by means of a fan.

## Table III.

**X3.**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | .54 | 1.55 | .40 | .88 | .39 | .40 | 4.16 | 24.96 | 57.15 |
| B. | .13 | .23 | .23 | .11 | .13 | .19 | 1.02 | 6.12 | 14.02 |
| C. | .12 | .86 | .28 | .25 | .34 | .04 | 1.89 | 11.34 | 26.01 |
| D. | — | — | — | .02 | .07 | — | .09 | .54 | 1.23 |
| E. | .01 | .05 | .01 | .03 | — | — | .10 | .60 | 1.33 |
| F. | .01 | — | — | — | — | — | .01 | 06 | .13 |
| G. | — | — | — | .01 | — | — | .01 | .06 | .13 |
| Total | .81 | 2.69 | .92 | 1.30 | .93 | .63 | 7.28 | 43.68 | 100 |

## Table IV.

**X4.**

| Grade. | Lbs. per Plant. | | | | | | | Tons per Acre. | Per Cent. of Total. |
|---|---|---|---|---|---|---|---|---|---|
| | May. | June. | July. | Aug. | Sept. | Oct. | Total. | Total. | |
| A. | .64 | .75 | .46 | .99 | .21 | .30 | 3.35 | 20.10 | 57.65 |
| B. | .17 | .21 | .17 | .11 | .11 | .22 | .99 | 5.94 | 17.03 |
| C. | .10 | .44 | .24 | .26 | .17 | .07 | 1.28 | 7.68 | 22.04 |
| D. | — | .01 | .02 | .01 | .04 | .01 | .09 | .54 | 1.55 |
| E. | .04 | .03 | .01 | — | — | — | .08 | .48 | 1.38 |
| F. | .02 | — | — | — | — | — | .02 | .12 | .35 |
| G. | — | — | — | — | — | — | — | — | — |
| Total | .97 | 1.44 | .90 | 1.37 | .53 | .60 | 5.81 | 34.86 | 100 |

The atmosphere of the house was analysed periodically during and after the introduction of the gas. The amount of gas found to be present was generally low, and varied considerably. The highest concentration recorded was 0.11% but generally speaking it rarely exceeded 0.06%. We consider that this concentration is insufficient to have any favourable effect on the crop, and this view was fully justified by the pickings, which were only the same as those in untreated houses on the nursery.

In view of the low concentrations of carbon dioxide obtained by the commercial apparatus, an experiment was made in order to test the possibility of obtaining high concentrations in large commercial glasshouses.

Seventy-four pounds of sodium bicarbonate were decomposed in a large earthenware vessel and the carbon dioxide was pumped into the house by means of a fan.

Samples were taken at intervals at various distances along the house and at different heights.

An average of 6 samples, taken twenty-five minutes after the commencement of the decomposition showed that 0.59% carbon dioxide was present. A sample from the inflow pipe gave 4.22% carbon dioxide. Four samples taken three quarters of an hour after complete decomposition yielded an average of 0.29% carbon dioxide.

The experiment serves to show that the artificial reinforcement of the carbon dioxide content of the atmosphere of large commercial glasshouses is possible. The substantial increases obtained in the small chambers during these investigations are considered to be a sufficient basis for stating that, given a commercial plant which could supply sufficient carbon dioxide at a moderate cost, the process of enriching the carbon dioxide content of glasshouse atmospheres by artificial means, is one which is worthy of consideration from a commercial point of view.

# Other Investigations.

## Blotchy Ripening of Tomato Fruits.

W. F. Bewley and H. L. White.

Irregular ripening of tomato fruits is familiar to all growers of this plant. It is of considerable importance, because it spoils the quality and appearance of the fruits. No matter how perfect their size and shape may be, tomato fruits must be packed as "roughs" if they do not ripen to a uniformly red colour. In many cases the percentage of unsightly fruit is as low as 0.5 or 1 per cent., so that monetary loss is not great; but under unfavourable conditions the amount of affected fruits may rise as high as 50 per cent., thus seriously lowering the market value of the crop.

### 1. Different Kinds of Irregularly Ripened Fruits.

Irregularly ripened tomato fruits in this country may be divided into four classes:

(*a*) Fruits suffering from "Stripe" disease caused by *Bacillus lathyri*. The surface of infected fruits show sunken, brown irregular pits and markings.

(*b*) Fruits suffering from Aucuba Mosaic disease, due to a filterable virus. Such fruits are prettily marked, the various markings having sharply defined edges. At times the fruits are completely white, while at others flecks of brilliant red or orange are scattered over a silvery white background. Usually, patches of normal red, alternate with those of green, yellow and orange, sometimes in a manner reminiscent of a "Paisley" shawl. Normally the contour of the fruit is smooth, but in bad cases the surface is irregular and covered with pimples.

(*c*) Fruits suffering from "green back" or "hard back." These fruits possess a hard green area round the stalk end, while the rest of the fruit is softening and turning red. As the ripening processes continue, the affected area may either remain green or become orange in colour, but invariably it remains hard, even though the rest of the fruit is over-ripe. On cutting open such a fruit it will be seen that the flesh immediately below the hard green area is opaque, hard and green, whereas the rest is clear, soft and red. The vascular bundles within the hard flesh are usually green in colour, and browning of the bundles has not been observed. Comparative microscope sections of the hard flesh and the mature flesh show the cells of the former to be in an immature condition. They are small and have not swollen. The flesh is less mucilaginous than normal, and frequently the wall of the fruit is thinner than in the riper areas.

(*d*) True blotchy ripening. In fruits affected by this disorder the hard green areas are not confined to the stalk end, but may arise in any position. Uusually there is no abrupt line of demarkation between the green and red areas ; the colours merge gradually. The observations previously recorded concerning the hard areas in "green back" apply equally well in the case of "blotchy ripening," but in the latter case the vascular bundles are sometimes brown and necrotic. In the most severe cases, the hard areas are not opaque and green, but are waxy or glassy in appearance, and thus give rise to the term "waxy patch" used by nurserymen. The bundles running through these clear, glassy areas are invariably brown and necrotic, a fact that may be easily observed from the outside. These fruits never ripen and are thus a dead loss to the grower. An attempt has been made to correlate the position of the affected areas with that of the various parts of the vascular system of the fruit cortex. They usually arise along the furrow immediately above a wall of one of the carpels composing the fruit. Occasionally they have been found immediately above the main bundle of the carpel.

**2. The Incidence of Blotchy Ripening.**

**(a) Seasonal Distribution.**

The symptoms, as in many nutritional disorders, are most severe about the month of June. Fruit ripening in September and October may be completely free from blotchy ripening, although the same plants in the early part of the season—late May, June and early July—may have borne fruit, forty-five per cent. of which was blotchy. The following table gives the percentage of blotchy fruit which was picked throughout the season, during five years, from the plot receiving nitrogenous and phosphatic fertilisers but no potash.

**Table I.**

**Seasonal Distribution of Blotchy Fruit.**

| Month | Percentage of Blotchy Fruits* | | | | |
|---|---|---|---|---|---|
| | 1921 | 1922 | 1923 | 1924 | 1925 |
| June ... | 28 | 19 | 11 | 18 | 32 |
| July ... | 45 | 36 | 33 | 14 | 27 |
| August | 8 | 22 | 12 | 4 | 37 |
| September | 2 | 43 | 10 | 5 | 3 |
| October | — | — | 15 | 10 | — |

* In 1921 and 1922 the variety grown was Kondine Red and in 1923, 1924 and 1925 Manx Marvel.

**(b) Varietal Susceptibility.**

A certain amount of varietal susceptibility to the causes underlying blotchy ripening undoubtedly exists. No variety remains consistently free from this disorder, but Kondine Red is so susceptible that this fact alone may cause its elimination when selecting varieties for commercial use. The variety Comet produces good quality fruit much less susceptible to imperfect ripening than that of Kondine Red. Thus the average percentage of blotchy fruit from Comet on an unmanured plot during 1921 and 1922 was 27.9, whereas Kondine Red under similar conditions gave 46.9 per cent. of this type of fruit.

**3. Effect of Manurial Treatment on Blotchy Ripening.**

**(a) The Relation of Blotchy Ripening to General Starvation.**

The frequent association of this disorder with unhealthy and starved-looking plants suggests that it is the result of malnutrition, and during the past five years a considerable amount of evidence in favour of this assumption has been obtained at the Cheshunt Station.

In 1923 a block of four houses was erected on grass land which had been undisturbed for countless years. These houses were set apart for experiments, which necessitated leaving one house unmanured, while the remaining three were given liberal dressings and every effort made to obtain a good crop. The crop yields for the first year as given in Table II. clearly show that the percentage of blotchy fruit averaging 4.15% in the well manured houses and 49.75% in the unmanured house is dependent upon manurial treatment. Similar results were obtained in 1924 and 1925.

**Table II.**

Percentage of blotchy fruits in 1923 from the plots of three manured houses and one unmanured house.

| Manured. | | Manured. | | Manured. | | Unmanured. | |
|---|---|---|---|---|---|---|---|
| Fallow | Fallow | 9.43 | 7.40 | 6.65 | 5.79 | Fallow | Fallow |
| 5.45 | 5.89 | 12.58 | 8.32 | 5.15 | 5.78 | 48.55 | 49.01 |
| 4.66 | 4.71 | 5.32 | 7.92 | 6.99 | 8.95 | 53.91 | 50.66 |
| 2.30 | 1.90 | 5.42 | 4.58 | 3.24 | 4.10 | 45.14 | 43.94 |

**(b) The Relation of Blotchy Ripening to Nitrogenous, Phosphatic and Potassic Nutrition.**

Examination of the fruits collected from the various experimental houses at Cheshunt has yielded information concerning the influence of different fertilisers on the ripening of the fruits. Two houses, which have been particularly useful, are 27 ft. wide and 100 ft. long. They were erected in 1915 and since 1916 each has been divided into eight equal plots 25 ft. long by 12 ft. wide containing 120 plants and occupying 1/145ths of a house acre. From 1916 to 1920 the results from these plots were measured as total weight of fruit collected, but from 1921 onwards the fruit from each plot has been collected, graded and weighed. In this way the effect of any particular treatment upon quality as well as quantity may be ascertained. One grade, separated in this way, is the grade of blotchy fruits. In Table III. is shewn the percentage of blotchy fruits obtained from the various plots in two similar houses. These plots have received the same treatment each year since 1916, except plots 1, 2 and 3 in both houses, which were started in 1919.

The outstanding feature of the results is the high proportion of blotchy fruits occurring on the unmanured plot and those plots from which potash and nitrogen respectively are withheld. On the remaining plots blotchy fruit is not absent entirely, but it is negligible in quantity and rarely rises above 3%.

The greatest proportion of blotchy fruits occurs on the unmanured plots, averaging over a period of five years 33% in one house and 35.9% in the other.

The average of the affected fruits over the same period from the potash starved plot is 19.3% in the first and 19.9% in the second house, while the average from the nitrogen-starved plot is 6.6% and 8.9% respectively. It should be noted also that the fruits from the phosphate-starved plots are only slightly affected, the five years' average being 0.7% in one house and 1.3% in the other. The proportion of blotchy fruits from the liberally-manured plots is noticeably low in both houses. It should be observed also that the proportion of blotchy fruits bears no relation to the size of the crop. Thus the plot receiving a double dressing of complete artificials has yielded a lower average crop than that receiving a single dressing, while the proportion of blotchy fruits from the former has been uniformly less than that from the latter.

## Table III.

| Treatment. | Percentage of Blotchy Fruit. | | | | | Average percentage of Blotchy Fruit during the 5 years 1921-1925. | Average crop in tons per acre during the 5 years 1921-1925. |
|---|---|---|---|---|---|---|---|
| | Kondine Red. | | Manx Marvel. | | | | |
| | 1921. | 1922. | 1923. | 1924. | 1925. | | |
| K1 Double complete artificials ... | 1.97 | 0.99 | 1.85 | 0.62 | 1.40 | 1.31 | 36.02 |
| K2 Unmanured ... | 57.16 | 36.65 | 18.45 | 24.45 | 43.25 | 35.93 | 29.24 |
| K3 Standard treatment + complete artificials ... | 2.77 | 1.90 | 2.28 | 0.38 | 1.95 | 1.86 | 38.24 |
| K4 Complete artificials + dung ... | 4.79 | 0.92 | 2.01 | 0.21 | 0.41 | 1.69 | 39.69 |
| K5 Complete artificials ... ... | 5.83 | 0.37 | 2.59 | — | — | 2.93 | 41.40 |
| K6 Complete artificials less phosphates ... ... | 6.37 | 0.21 | 2.52 | 0.61 | 1.35 | 2.21 | 37.46 |
| K7 Complete artificials less nitrogen | 23.99 | 7.15 | 8.73 | 2.07 | 8.92 | 10.17 | 35.45 |
| K8 Complete artificials less potash.. | 24.23 | 20.15 | 18.12 | 12.21 | 24.87 | 19.92 | 36.71 |
| | Comet. | | Manx Marvel. | | | | |
| J1 Double complete artificials ... | 3.11 | — | 2.22 | 2.43 | 0.62 | 1.68 | 36.05 |
| J2a Unmanured ... | 47.18 | 8.64 | 25.17 | 51.05 | 33.23 | 33.05 | 30.84 |
| J2b Stable manure only ... ... | — | — | — | — | 1.90 | 1.90 | 35.8 |
| J5 Complete artificials ... ... | 12.73 | — | 2.16 | 0.32 | 0.94 | 3.23 | 38.14 |
| J6 Complete artificials less phosphates ... ... | 8.75 | — | 1.60 | 2.22 | 0.71 | 2.66 | 37.42 |
| J7 Complete artificials less nitrogen | 27.65 | 0.28 | 10.23 | 3.75 | 0.60 | 9.70 | 33.51 |
| J8 Complete artificials less potash.. | 31.83 | 1.52 | 22.39 | 18.07 | 23.04 | 19.37 | 35.22 |

**Table IV.**

Elimination of Blotchy Fruit on Starved Plots by Addition of Potassic and Nitrogenous Fertilisers.

| Percentage of Phosphates in Fertiliser. | 0 | 8 | 16 | 24 | 32 |
|---|---|---|---|---|---|
| Per cent. Blotchy Fruit, 1923... ... | 1.60 | 0.68 | 2.61 | 2.98 | — |
| ,, ,, ,, ,, 1924... ... | 2.22 | 1.37 | 0.18 | 0.44 | — |
| ,, ,, ,, ,, 1925... ... | 0.71 | — | 0.36 | 0.19 | 0.19 |
| Average ... | 1.51 | 1.03 | 1.05 | 1.20 | 0.19 |

| Percentage of Nitrogen in Fertiliser. | 0 | 1¼ | 2½ | 5 | 7½ |
|---|---|---|---|---|---|
| Per cent. Blotchy Fruit, 1923... ... | 10.23 | 4.73 | 3.98 | 2.00 | — |
| ,, ,, ,, ,, 1924... ... | 3.75 | 0.78 | 0.16 | 0.27 | — |
| ,, ,, ,, ,, 1925... ... | 6.60 | — | 0.66 | 0.96 | .70 |
| Average ... | 6.86 | 2.75 | 1.60 | 1.08 | .70 |

| Percentage of Potash in Fertiliser. | 0 | 2½ | 5 | 7½ | 10 |
|---|---|---|---|---|---|
| Per cent. Blotchy Fruit, 1923... ... | 22.39 | 12.30 | 12.16 | 14.80 | — |
| ,, ,, ,, ,, 1924... ... | 18.07 | 6.22 | 4.39 | 3.57 | — |
| ,, ,, ,, ,, 1925... ... | 25.04 | — | 4.08 | 2.96 | .91 |
| Average ... | 21.83 | 9.26 | 6.88 | 7.11 | .91 |

**(c) The Elimination of Blotchy Fruits by Addition of Potassic and Nitrogenous Fertilisers.**

The results of the previous experiments suggest that the addition of potassic and nitrogenous fertilisers to soil starved in respect of these nutrients will cause a corresponding reduction in the proportion of blotchy fruits and experiments were arranged accordingly.

In 1923, three plots starved in phosphates, potash and nitrogen respectively were each subdivided into four equal sections to each of which was added different quantities of the particular fertiliser in which the plot was deficient. Thus the plot without phosphates was divided into four equal plots, one of which was without phosphate as before, the second had a mixture containing 8% phosphates, the third 16% and the fourth 24%. The nitrogen-starved plot was divided into four plots ; one was left without nitrogen, the others had $1\frac{1}{4}\%$, $2\frac{1}{2}\%$ and 5% nitrogen respectively. The plot deficient in potash was also divided into four plots ; one without, the others with $2\frac{1}{2}\%$, 5% and 7% potash respectively. Nitrogen was added as sulphate of ammonia, potash as sulphate of potash and phosphate as superphosphate. These treatments were repeated in 1924, and in 1925 the amounts of the different nutrients were uniformly increased as shown in the accompanying Table IV. The results given in the table show that the percentage of blotchy fruits is reduced by the application of nitrogen as sulphate of ammonia and potash as sulphate of potash. Increased dressings of phosphates as superphosphates have not materially affected the proportion of these fruits, and it is clear that phosphate is not a factor involved in their production.

**(d) The Effect of Stable Manure on Blotchy Ripening.**

In 1925 a plot unmanured for six years was divided into two equal sections ; one was left unmanured as before, while stable manure at the rate of 14 lbs. per sq. yd. was dug into the soil of the other section 28 days before planting.

The resulting crop showed 33.05% of blotchy fruit in the unmanured section and 1.9% in the manured section.

**4. The Effect of Climatic Factors on Blotchy Ripening.**

It is apparent from Table III. that a certain proportion of the fruits become blotchy even when the soil is liberally manured. For example, the amount of blotchy fruits for a period of five years on the plots receiving complete artificials has been as follows :—

| | 1st House. | 2nd House. |
|---|---|---|
| 1921 ... ... ... | 12.73 ... | 5.83 |
| 1922 ... ... ... | — ... | 0.37 |
| 1923 ... ... ... | 2.16 ... | 2.59 |
| 1924 ... ... ... | 0.32 ... | — |
| 1925 ... ... ... | 0.94 ... | — |

Plainly some other factor or factors influence the minimum amount of blotchy ripening, the annual variation of which is similar in the two houses. Climatic factors at once suggest themselves as the cause of this variation and while further study is necessary before reliable conclusions may be drawn there are indications that sunlight is one important factor.

Table III. suggests that the effect of sunlight on the ripening of tomato fruits coincides to some extent with that of potassic fertilisers, for the proportion of blotchy fruits from the nitrogen-starved plots in 1921, which was a sunny year, approximates to that from the potash-starved plots. In the less sunny years, 1922 and 1923, there was considerably more blotchy fruits from the potash-starved plots than from the nitrogen-starved plots. Also during the very dull season of 1924, the ratio was still further increased.

**5. The Effect of Root Diseases on Blotchy Ripening.**

Cases have been observed of single plants in well manured plots producing an abnormal amount of blotchy fruits. The plants have invariably been weak specimens and examination of the roots showed them to be badly attacked by the root fungus, *Colletotrichum atramentarium*, by which name *C. tabificum* must now be known.

**6. Discussion of Results.**

The foregoing experimental results leave no doubt that blotchy ripening of tomato fruits is connected with an insufficient supply of available potassic and nitrogenous foods; phosphate deficiency appears to be unimportant. Further, the feeding of affected plants with potassic and nitrogenous fertilisers causes a corresponding reduction in the quantity of fruits affected. Under the most favourable manurial conditions, however, a small quantity of blotchy fruits is invariably produced, and it is apparent that other factors are operative in a small way. This remarkable response to potash deficiency is not altogether surprising because analysis of tomato fruits has shewn them to be remarkably rich in potash. Thus Patterson* who made 612 determination found an average of 67.3 per cent. of potash in the ash.

*Patterson, J., Report of the Chemist, Md. Agr. Exp. Sta. Ann. Rpt., 1899.

Although potash and nitrogen are both important factors in the ripening of tomato fruits, the former is by far the more important of the two. In actual advisory work it has been found that the application of sulphate of potash at the rate of 5 cwts. per acre is sufficient to correct blotchy ripening on average soils. On the other hand, cases are known where the soil is so unbalanced that three tons sulphate of potash per acre had to be applied before blotchy ripening was reduced to negligible proportions. In cases where both potash and nitrogen are deficient, two dressings at an interval of ten days each of a mixture of 2½ cwts. sulphate of ammonia and 2½ cwts. sulphate of potash per acre has proved successful.

It should be borne in mind, however, that all plants grown in soils liberally provided with potash and nitrogen are not necessarily well nourished in respect to these nutrients. The nourishment of the plant depends upon a healthy root action and sufficient water in the soil to carry the nutrients. Realisation of these simple facts has frequently solved growers' problems which soil analysis has failed to elucidate. Thus tomato plant roots are frequently parasitised by a fungus *Colletotrichum atramentarium* which appreciably reduces the size of the functioning root system. Plants affected in this way cannot be well nourished, although growing in fertile soil. Again, a common fault in tomato cultivation is dryness of the soil below the top six inches. If the lower part of the soil is once allowed to become dry, it is exceedingly difficult to wet it during the growing season, and the result is detrimental to the plant. In several cases blotchy ripening has been traced to a dry base, and corrected by taking special measures to wet it.

The position regarding "green back" is not so simple. Susceptibility to this disorder follows the same laws as blotchy ripening, being increased by a deficiency of potash and nitrogen, but the ultimate symptoms seem to be intensified by exposure of the fruits to strong sunlight.

Duggar* shewed that when tomato fruits, which are normally red when ripe, are ripened at 90°F. or above, they become when fully ripe yellow instead of red. He further shewed that tomatoes ripened in the absence of oxygen also became yellow instead of red. Thus the red pigment, lycopin, does not develop at high temperatures and in the absence of oxygen. In green back the affected tissues do not develop lycopin but assume an orange-yellow colour.

It is reasonable to assume that the paucity of this pigment is due to the heating of the tissues by exposure to the direct rays of the sun. This assumption is confirmed by observation of

* Duggar, B.M. (1913), Washington University Studies, Vol. 1, Pt. 1, No. 1.

plants grown in commercial nurseries, for the fruits from plants with scanty foliage, or those trimmed too severely have almost invariably shewn a high proportion of "green back." The prevention of "green back" seems to depend upon liberal manuring with potassic fertilisers and suitable shading of the glass during the height of the summer.

**Summary.**

1) Blotchy ripening of tomato fruits is the result of malnutrition in respect of potash and nitrogen, especially the former. Phosphates seems to be unimportant in this respect.

(2) The proportion of blotchy fruits may be reduced to less than 1 per cent. by suitable applications of sulphate of potash and sulphate of ammonia.

(3) Blotchy ripening has not been eliminated entirely by manurial treatment. Other factors probably climatic in nature, play some part in the incidence of this disorder.

(4) Root-invading fungi, such as *Colletotrichum atramentarium*, interfere with the feeding of the plant and indirectly cause blotchiness of the fruit.

(5) Exposure of the fruits to excessive sunlight causes a type of blotchiness known as "green back" if the nitrogen and potash supply is inadequate.

(6) Blotchy ripening may be accompanied by necrosis of the vascular bundles of the fruit.

## A Preliminary Report on the Blooming and Fruiting Period of the Tomato Plant.

W. Corbett.

The present investigation forms part of a larger scheme of the Directors, which has for its object the intensive study of the tomato plant.

Daily records of the growth of six varieties of tomato plants were made. These records included the dates of (1) the unfolding of each leaf, (2) the opening of each flower, (3) the pollination of each flower, and (4) the picking of each fruit.

Representative plants, two of each, of the following varieties were chosen, Comet, Clarke's Masterpiece, Tuckswood, Pale Blako, Ailsa Craig and Manx Marvel. The plants were situated

in the front rows of the variety trial house at the Experimental Station, and the treatment they received was that which is general throughout the Lea Valley.

**Results.**

The time taken from the opening of the flower to the picking of the fruit was calculated for each individual fruit on the first five trusses of each plant. This period will be referred to as the "Maturation Period." The average times taken by the fruits of each truss, for three of the varieties under observation, is tabulated in Table I.

**Table I.**

| Variety. | Average Length, in Days, of the "Maturation Period." | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Truss 1. | | Truss 2. | | Truss 3. | | Truss 4. | | Truss 5. | |
| | No. of Fruit. | Av. No. of Days per Fruit. | No. of Fruit. | Av. No. of Days per Fruit. | No. of Fruit. | Av. No. of Days per Fruit. | No. of Fruit. | Av. No. of Days per Fruit. | No. of Fruit. | Av. No. of Days per Fruit. |
| Ailsa Craig ... | 10 | 59.3 | 11 | 64.6 | 15 | 70.4 | 14 | 62.5 | 8 | 64.7 |
| Comet ... ... | 7 | 58.1 | 6 | 55.6 | 8 | 102.9 | 8 | 86.9 | 11 | 83.2 |
| Manx Marvel ... | 9 | 67.3 | 17 | 77.2 | 11 | 74.3 | 11 | 73.9 | — | — |

On inspection of the Table it will be readily seen that the "Maturation Period" lengthens up to the third truss, after which for the fourth and fifth trusses it shortens. This is noteworthy in as much as this period might be expected to lengthen gradually as the season advances instead of lengthening to an apparent maximum and then becoming shorter.

Further analysis, Table II., shows that when a truss bears a large number of fruits there is a considerable lengthening of the "Maturation Period" of those after the seventh, eighth or ninth.

Particularly prominent is the sudden increase in the length of this period from seventy-seven days in the case of fruit 13, Truss 2 (Table II.), to ninety-four days in the case of fruit 14, Truss 2, an increase of seventeen days. This sudden lengthening of the "Maturation Period" also occurs in Truss 3 (Table II.) with the eighth and ninth fruits, and in Truss 4 (Table II.) with the sixth and seventh fruits, and is probably shown better in the accompanying Fig. 1.

**Table II.—Variety, Manx Marvel.**

| Truss 1. | | Truss 2. | | Truss 3. | | Truss 4. | |
|---|---|---|---|---|---|---|---|
| No. of Fruit. | Length, in Days, of "Maturation Period." | No. of Fruit. | Length, in Days, of "Maturation Period." | No. of Fruit. | Length, in Days, of "Maturation Period." | No. of Fruit. | Length, in Days, of "Maturation Period." |
| 1 | 65 | 1 | 64 | 1 | 65 | 1 | 58 |
| 2 | 64 | 2 | 63 | 2 | 62 | 2 | 62 |
| 3 | 64 | 3 | 61 | 3 | 65 | 3 | 58 |
| 4 | 63 | 4 | 69 | 4 | 66 | 4 | 61 |
| 5 | 68 | 5 | 72 | 5 | 69 | 5 | 62 |
| 6 | 65 | 6 | 69 | 6 | 67 | 6 | 62 |
| 7 | 63 | 7 | 71 | 7 | 67 | 7 | 85 |
| 8 | 69 | 8 | 71 | 8 | 70 | 8 | 92 |
| 9 | 85 | 9 | 72 | 9 | 93 | 9 | 91 |
| — | — | 10 | 71 | 10 | 99 | 10 | 88 |
| — | — | 11 | 78 | 11 | 94 | 11 | 93 |
| — | — | 12 | 77 | — | — | — | — |
| — | — | 13 | 77 | — | — | — | — |
| — | — | 14 | 94 | — | — | — | — |
| — | — | 15 | 91 | — | — | — | — |
| — | — | 16 | 102 | — | — | — | — |
| — | — | 17 | 105 | — | — | — | — |

With regard to the actual number of fruits picked in comparison with the number of flowers produced, only in one variety, viz., Clarke's Masterpiece, was the difference of any importance. In this variety approximately 20% of the flowers failed to develop into fruits. The cause of this failure was not investigated.

**Discussion.**

Although a complete analysis of the results from only one variety is given, the results from all the varieties under observation were similar.

On first consideration it may appear that the increase in time between the opening of the flowers and the picking of successive fruits of the second, third and fourth trusses, is due, either to a temperature factor or a combination of climatic factors. The overlapping of the graphs in the diagram, Fig. 1, suggests that temperature and other climatic factors have but little bearing on the observed lengthening of the "Maturation Period," and that the increase is caused by the growth and development of the upper part of the plant.

Nothing further, however, can be said of this until further work on the subject has been carried out.

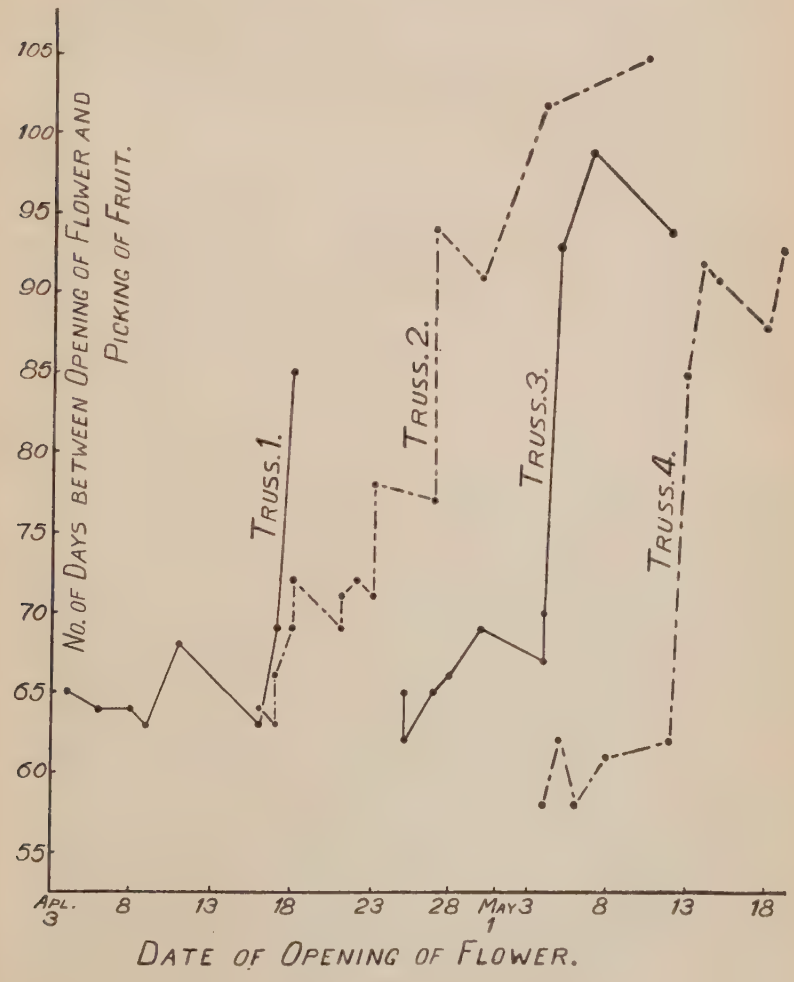


Fig. 1.

# Some Observations on the Progeny of a Single Tomato Plant.

W. F. Bewley and A. A. Richards.

During the course of the experiments which are conducted each year in the houses at the Station, it has been noted continually that certain tomato plants produce yields much in excess of the average. The yield per plant rarely exceeds six pounds except in the first three or four years on virgin soil, while that from the abnormal plants may reach as much as eighteen pounds per plant. Nurserymen have long attempted to fix this heavy cropping strain but without result, and it was thought that better results might be obtained if the seed from each fruit on the plant was saved separately and sown so that the history of the progeny of each fruit could be kept.

For this purpose an exceptionally good plant of Ailsa Craig was selected and marked (P 5 (1), 1924), the total weight of fruit given by the plant being twelve pounds. The strain used was not pure, having been crossed with the variety Blaby many generations previously. The seeds were taken from each fruit, and stored separately in specimen tubes. They were sown in December, 1924, using one box for each fruit, and later the seedlings were planted in a house, so that those from each fruit occupied a separate plot.

The resulting plants were examined weekly and are described below. Segregation of characters seems to have taken place within the plant, in the example selected for this experiment, since the plants from different fruits vary considerably.

Out of the eleven fruits used for the experiment, four gave no true Blaby descendants, while in three the ratio was 1 Blaby to 89 Ailsa Craig, 1 Blaby to 39 Ailsa Craig and 1 Blaby to 109 Ailsa Craig. The remaining four fruits (which included the first fruits of the first and second trusses) produced Ailsa Craig and Blaby types in the ratio of from 3 to 1 to 6 to 1.

The Ailsa Craig plants from all fruits, with three exceptions, conformed to the following description.

**Tomato, Ailsa Craig.**

Ailsa Craig is a type with no striking characters. In its seedling stage it resembles many other varieties except that the foliage is distinctly long and spreading, while the last leaflet is often as large and slightly broader than the other leaflets.

In mature plants the foliage is large, long and rambling and of a deep green colour. The leaves are placed well apart and the trusses are uniform both in size and shape. Immediately the fruits have "set" the truss hangs fairly closely to the main stem. The fruit is almost spherical and deep red when ripe, while the calyx is well turned towards the stem. The fruit has a distinct tart flavour, which is not possessed by any other type. Branching of the trusses is not so frequent as in some other varieties.

Two of the exceptions were the first fruits from both the first and second trusses. Although these fruits were of excellent shape, size and colour, their seeds produced Ailsa Craig plants of a very coarse type. In mass, the plants had a ragged appearance. The foliage was long, straggling and pale in colour, with small leaflets. The trusses were branched, often as many as four times, and the fruits were ribbed and of poor shape.

The third exception was the second fruit on the fourth truss, which gave rise to an abnormally good batch of plants, which although resembling Ailsa Craig, were not true to type, the foliage being slightly smaller and paler than the latter variety. The plants grew uniformly and had a remarkably neat appearance.

The Blaby plants were fairly true to type and conformed to the following description.

**Tomato, Blaby.**

The characters of this variety are distinct and from the seedling stage onwards it has peculiarities not found in other varieties except those derived from it. The young plants are of a bright, yellowish green colour, especially at the growing points, and the stems are whitish green. The same colour persists in the foliage after planting in the houses. The plants are short and very compact. Instead of long, rambling leaves like Ailsa Craig, they have much shorter ones, which become almost pendulous after two-thirds of their length has been reached. The stems of the trusses are bright green, the trusses themselves being compact, bending outwards and downwards instead of "drooping." The stems of the trusses are distinctly hard and wiry and are thickened abnormally where they join the main stem. The fruit is quite round, medium sized and quick to develop and ripen. Its colour is a distinct shade of orange pink when turning, and a bright reddish pink when quite ripe. It possesses a flavour sweeter than that of Ailsa Craig.

**Observations of the Progeny of Plant known as P5 (1) 1924.**

**Truss 1. Fruit 1. (Poor type).**

One hundred and twenty plants were raised from the seed of this fruit. Two types of plants appeared, one (22) resembling Blaby and the other (98) Ailsa Craig.

Blaby was fairly true to type, but Ailsa Craig was of a very inferior type. The foliage was long and spreading; the leaflets small and much paler than usual, which gave the plants a "ragged" appearance. The fruit was "ribbed" and of poor shape. The trusses of the Blaby plants were fairly true to type, but those of Ailsa Craig were divided into the following three groups :—

1. Blaby, but slightly longer.

2. Ailsa Craig.

3. A rambling type, resembling "Buck's Tresco." This one invariably had fruits on which the ribbing was most pronounced. Some of the trusses held as many as twenty fruits, varying from a medium-sized *"blue" down to the size of a cherry. This type of truss was †double in all cases. Doubling in trusses gradually died out as the height of the plant increased, so that when the seventh truss was reached the trusses were all single.

The ratio of trusses were as follows :—

| | Blaby type. | | Ailsa Craig type. | |
|---|---|---|---|---|
| | Double. | Single. | Double. | Single. |
| 1st Truss ... | — | — | — | — |
| 2nd ,, ... | 21 | 1 | 98 | — |
| 3rd ,, ... | 18 | 4 | 69 | 29 |
| 4th ,, ... | 15 | 7 | 64 | 34 |
| 5th ,, ... | 19 | 3 | 38 | 60 |
| ‡6th ,, ... | 6 | 16 | 19 | 79 |

**Truss 1, Fruit 3. Ailsa Craig, 109; Blaby, 1**

The Ailsa Craig type here was far superior to that produced by fruit 1 of this truss. The leaves were large, long and spreading, and possessed the deep green colour of Ailsa Craig. Both fruit and habit of trusses were true to Ailsa Craig.

* This grade consists of fruit of good colour but large and irregular in shape.

† The stem of the truss was divided into two equal branches.

‡ All trusses after the sixth were single.

The Blaby type was true in habit, foliage and fruit. All the trusses were single.

Only four double trusses appeared, all being among the first in the Ailsa Craig type.

**Truss 2, Fruit 1. Ailsa Craig, 65; Blaby, 15.**

This Ailsa Craig was a poor type. The leaves were long and spreading and the leaflets about two-thirds normal size. The plants had a ragged appearance. The fruit was wrinkled and of poor quality, while the trusses were identical to those found in fruit 1, truss 1, but with a larger percentage of small fruit.

The Blaby plants were a modified type. The foliage was typical, but did not hang so closely to the main stem, and the trusses were more open and spreading. The fruit was good, but on many trusses the first fruit was large and distorted.

Branching was fairly consistent up to the fifth truss, after which it disappeared.

| | Ailsa Craig. | | Blaby. | |
|---|---|---|---|---|
| | Single. | Double. | Single. | Double. |
| 1st truss ... | — | 65 ... ... | — | 15 |
| 2nd ,, ... | 18 | 47 ... ... | 6 | 9 |
| 3rd ,, ... | 25 | 40 ... ... | 3 | 12 |
| 4th ,, ... | 13 | 54 ... ... | 5 | 10 |
| 5th ,, ... | 14 | 53 ... ... | — | — |

Three double trusses appeared on Blaby in the 8th truss.
All other trusses were single.

**Truss 2, Fruit 2.**

The plants (40) were all of the Ailsa Craig type. The leaves were normal, the fruit was of good quality and regular in shape The trusses up to the ninth were single throughout, with the exception of three doubles among the first trusses.

**Truss 2, Fruit 3. Ailsa Craig, 122: Blaby, 38.**

The Ailsa Craig was almost true to type, the foliage being normal. There was practically no wrinkling of the fruit. The Blaby was typical and possessed a good habit and fruit. Doubling only appeared among the first trusses.

| | Ailsa Craig. | | Blaby. | |
|---|---|---|---|---|
| | Double. | Single. | Double. | Single. |
| 1st Truss ... | 7 | 115 ... ... | 3 | 35 |

**Truss 3, Fruit 1. Ailsa Craig, 39; Blaby, 1.**

The Ailsa Craig was a good type, but the Blaby plant was not typical, the foliage being the colour of Blaby, while the leaves were long and spreading and the leaflets large. The fruit was slightly larger than that of Blaby. Only six double trusses appeared and they were all on the Ailsa Craig plants, five being first trusses and one a second truss.

This Ailsa Craig was the nearest to the true type in the whole series.

**Truss 3, Fruit 2.**

There were 40 plants of one type only, namely, Ailsa Craig. No wrinkling of the fruit was found at any time, and to the ninth truss it was good in all respects.

One double truss appeared and that amongst the first.

**Truss 3, Fruit 3.**

All the plants (40) were of the Ailsa Craig type. Only three double trusses appeared, two of which were on the same plant.

**Truss 3, Fruit 4. Ailsa Craig, 89; Blaby, 1.**

Ailsa Craig was typical in habit, foliage and fruit.

Blaby was not a good type. The foliage was rather large and spreading, and the trusses rambling, but the fruit was a good shape. Doubling appeared among the first trusses only, Ailsa Craig yielding five and Blaby two double trusses.

**Truss 4, Fruit 2.**

The plants (80) were of one type only and resembled Ailsa Craig, but they were not true to type, the foliage being slightly smaller and paler. The plants grew very uniformly, with a neat and regular appearance. There were no rogues. The fruit was excellent. No wrinkling appeared, every one being perfect in shape. Only two double trusses appeared, both among the first.

**Truss 4, Fruit 4. Ailsa Craig, 86; Blaby, 14.**

The Ailsa Craig was a good type, the fruit being of good quality. The Blaby plants were not a true type. The foliage was longer and more spreading and the trusses varied among the first, second and third. Some were compact, as in the type, but others were more spreading. Many fruits were wrinkled on various trusses.

Doubling appeared only on the first truss in Ailsa Craig (2), but up to the third in Blaby.

**Conclusions.**

(1) The tomato Ailsa Craig × Blaby selected for the foregoing experiment exhibited segregation of characters within the plant.

(2) The plants raised from seed taken from different fruits on this plant, varied from fruit to fruit.

(3) Out of eleven fruits used, four gave no Blaby descendants, while in three the ratio varied between 1 Blaby to 39 Ailsa Craig and 1 Blaby to 109 Ailsa Craig. The remaining four fruits gave a ratio between 1 to 3 and 1 to 6.

(4) The Blaby descendants were generally truer to type than those of Ailsa Craig.

(5) The Ailsa Craig plants from the first fruits of the first and second trusses were markedly coarser than the type. The leaves were straggling, trusses branched, and the fruit was of bad shape.

(6) With one exception the remaining batches of Ailsa Craig conformed to type. The exception came from the second fruit of the fourth truss, which produced an exceptionally good batch of plants, with smaller and paler foliage than Ailsa Craig. Each seed in the fruit produced the same type of plant, and the type has been found to breed true.

(7) The results suggest an easy means of obtaining new varieties which will remain true to type during future cultivation.

## Meteorological Records, 1925.

| Month. | Rain. | | Average outside Temperatures. | | Bright Sunshine. |
|---|---|---|---|---|---|
| | Total fall. 5 inch Funnel Gauge. | No. of Rainy Days. | Day Maxm. °F. | Night Minm. °F. | Daily average in hours. |
| | Inches. | | | | |
| January ... ... | 1.71 | 14 | 44.8 | 33.2 | 1.36 |
| February ... ... | 3.24 | 17 | 46.6 | 36.4 | 1.26 |
| March ... ... .. | 0.81 | 12 | 46.8 | 34.8 | 2.96 |
| April ... ... ... | 1.54 | 16 | 54.1 | 38.5 | 4.54 |
| May ... ... .. | 2.00 | 18 | 62.2 | 46.8 | 6 50 |
| June ... ... ... | 0.13 | 2 | 69.8 | 49.6 | 8.71 |
| July ... ... ... | 3.99 | 13 | 75.3 | 54.7 | 5.69 |
| August ... ... ... | 2.70 | 16 | 68.0 | 53.7 | 4.30 |
| September ... ... | 2.76 | 18 | 60.6 | 56.3 | 4.04 |
| October... ... ... | 2.82 | 14 | 58.5 | 45.0 | 3.26 |
| November ... ... | 1.62 | 14 | 44.9 | 35.2 | 2.70 |
| December ... ... | 2.18 | 1 | 42.0 | 32.6 | 1.44 |
| Total or Mean... ... | 25.50 | 155 | 56.1 | 43.1 | 4.10 |

**Dates of Cultural Operations during 1924—1925.**

| Crop. | Sown. | Potted into 60's. | Potted into 32's. | Planted out in borders. | First Mulching. | First Top Dressing. | First Fruit Picking. | Last Fruit Picking. |
|---|---|---|---|---|---|---|---|---|
| Tomatoes ... ... | Dec. 29 1924 | Feb. 6 1925 | —— | Mar. 12 1925 | May 14 1925 | *May 6 1925 | May 12 1925 | Oct. 30 1925 |
| Cucumbers ... ... | Dec. 29 1924 | Jan. 6 1925 | Jan. 29 1925 | Feb. 17 1925 | —— | Mar. 17 1925 | Mar. 23 1925 | Oct. 6 1925 |

* Plots J5, J6, J7 and J8 received one top-dressing when planted, and the second top-dressing on May 6th, 1925.